Solutions

Each answer shows the steps, then the **result**.

2.1

- time constant:
$$\tau = RC = (5.0 \times 10^{3}\ \Omega)(20 \times 10^{-6}\ \text{F})$$
- $\tau = \mathbf{0.10}$ s

2.2

- zero (the capacitor is fully charged)

2.3

- $q(t) = Q\,e^{-t/\tau}$

3.1 B

- RC.

3.2 B

- plain wire.

3.3

(a)

- time constant:
$$\tau = RC = (2.0 \times 10^{3}\ \Omega)(50 \times 10^{-6}\ \text{F})$$
- $\tau = \mathbf{0.10}$ s

(b)

- at $t = 0$ the uncharged capacitor has no voltage, so the whole supply is across R:
$$I_0 = \frac{V}{R} = \frac{10\ \text{V}}{2.0 \times 10^{3}\ \Omega}$$
- $I_0 = \mathbf{5.0 \times 10^{-3}}$ A

3.4

(a)

- for capacitors in series the reciprocals add:
$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{30\ \mu\text{F}} + \frac{1}{60\ \mu\text{F}} = \frac{3}{60\ \mu\text{F}}$$
- $C_{\text{eq}} = \mathbf{20}\ \mu$F

(b)

- the time constant is $\tau = RC_{\text{eq}}$:
$$\tau = RC_{\text{eq}} = (5.0 \times 10^{3}\ \Omega)(20 \times 10^{-6}\ \text{F})$$
- $\tau = \mathbf{0.10}$ s

(c)

- series capacitors carry the same charge as C_{eq}; for charging, $Q = C_{\text{eq}}\mathcal{E}\left(1 - e^{-t/\tau}\right)$ with $t = \tau$:
$$Q = C_{\text{eq}}\mathcal{E}\left(1 - e^{-t/\tau}\right) = (20 \times 10^{-6}\ \text{F})(12\ \text{V})\left(1 - e^{-1}\right)$$
- $Q = \mathbf{1.5 \times 10^{-4}}$ C on each capacitor

(d)

- finally no current flows, so the full 12 V is across the capacitors, which hold the same charge:
$$Q_{\text{final}} = C_{\text{eq}}\mathcal{E} = (20 \times 10^{-6}\ \text{F})(12\ \text{V}) = 2.4 \times 10^{-4}\ \text{C}$$
- $V_1 = \dfrac{Q_{\text{final}}}{C_1}$:
$$V_1 = \frac{Q_{\text{final}}}{C_1} = \frac{2.4 \times 10^{-4}\ \text{C}}{30 \times 10^{-6}\ \text{F}}$$
- $V_1 = \mathbf{8.0}$ V