Current and Resistance

7. V The quantity of charge q (in coulombs) that has passed through a surface of area $2.00\ cm^2$ varies with time according to the equation $q = 4t^3 + 5t + 6$, where t is in seconds. (a) What is the instantaneous current through the surface at $t = 1.00$ s? (b) What is the value of the current density?

34. Q|C Lightbulb A is marked "25 W 120 V," and lightbulb B is marked "100 W 120 V." These labels mean that each lightbulb has its respective power delivered to it when it is connected to a constant 120-V source. (a) Find the resistance of each lightbulb. (b) During what time interval does 1.00 C pass into lightbulb A? (c) Is this charge different upon its exit versus its entry into the lightbulb? Explain. (d) In what time interval does 1.00 J pass into lightbulb A? (e) By what mechanisms does this energy enter and exit the lightbulb? Explain. (f) Find the cost of running lightbulb A continuously for 30.0 days, assuming the electric company sells its product at $0.110 per kWh.

7. (a) $i(t) = \dfrac{dq(t)}{dt} = \dfrac{d\,(4t^3+5t+6)}{dt}$

$= 12t^2 + 5$

$i(1) = 17 \ (A)$ #

(b) $J = \dfrac{I}{A} = \dfrac{17}{2\times10^{-4}} = 8.5\times10^{4} \ (A/m^2)$

#

34.

A  B 

25W, 120V   100W, 120V

$P = IV = I^2R = \dfrac{V^2}{R}$

(a) $R = \dfrac{V^2}{P}$

$$\begin{cases} R_A = \dfrac{(120)^2}{25} = 576 \ (\Omega) \\ R_B = \dfrac{(120)^2}{100} = 144 \ (\Omega) \end{cases}$$ #

(b) $I = \dfrac{\Delta Q}{\Delta t} \Rightarrow \Delta t = \dfrac{\Delta Q}{I}$

$P = IV \Rightarrow \dfrac{1}{I} = \dfrac{V}{P}$

$\Rightarrow \Delta t = \dfrac{V \cdot \Delta Q}{P}$

$= \dfrac{120 \cdot 1}{25} \approx 4.8\ (s)$ #

(c) No (Conservation of charge)

(d) $P = \dfrac{W}{\Delta t} \Rightarrow \Delta t = \dfrac{W}{P} = \dfrac{1}{25} = 0.04(s)$

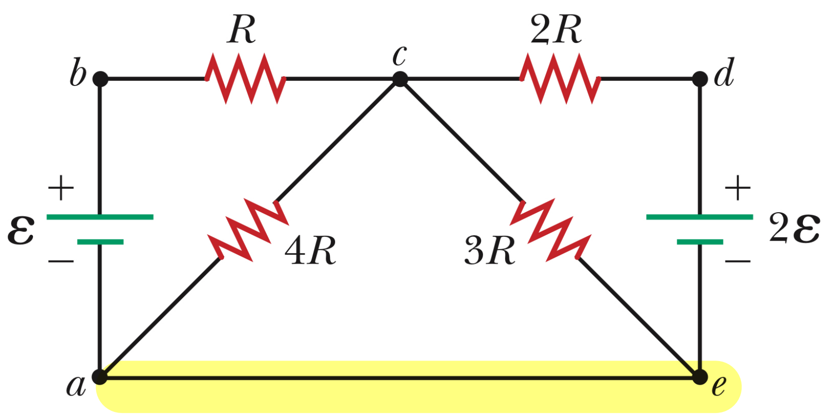
(e) $\begin{cases} \text{enter : electrical energy} \\ \text{exit : thermal energy and radiation} \end{cases}$

(f) $\text{cost} = 0.11 \times (0.025 \times 30 \times 24)$

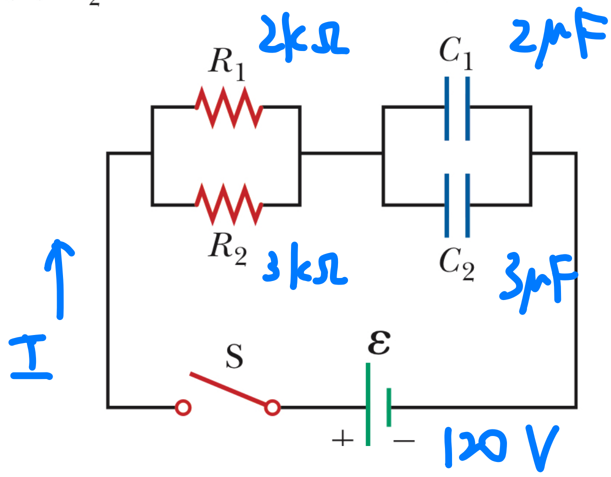
$= \$\ 19.8$ #

DC Circuit

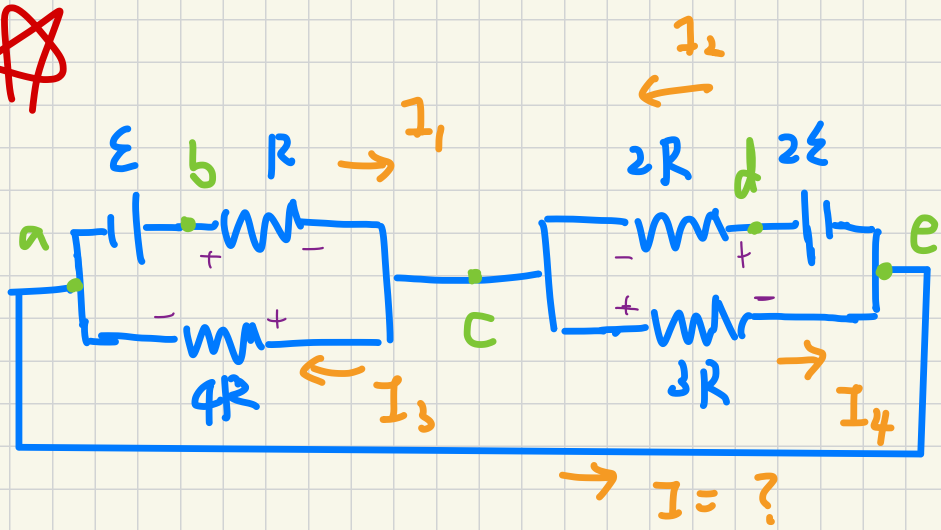
19. Taking $R = 1.00\ \text{k}\Omega$ and $\mathcal{E} = 250$ V in Figure P27.19, determine the direction and magnitude of the current in the horizontal wire between a and e.



41. The circuit in Figure P27.41 contains two resistors, $R_1 = 2.00\ \text{k}\Omega$ and $R_2 = 3.00\ \text{k}\Omega$, and two capacitors, $C_1 = 2.00\ \mu\text{F}$ and $C_2 = 3.00\ \mu\text{F}$, connected to a battery with emf $\mathcal{E} = 120$ V. If there are no charges on the capacitors before switch S is closed, determine the charges on capacitors (a) C_1 and (b) C_2 as functions of time, after the switch is closed.



19.



$R = 1\ k\Omega$

$\varepsilon = 250\ V$

① Loop 1: $a \to b \to c \to a$

$$\varepsilon - I_1 R - I_3 (4R) = 0$$

$$\Rightarrow I_1 + 4 I_3 = 250\ (mA)$$

② Loop 2: $e \to d \to c \to e$

$$2\varepsilon - I_2 (2R) - I_4 (3R) = 0$$

$$\Rightarrow 2 I_2 + 3 I_4 = 500\ (mA)$$

③ Loop 3: $c \to a \to e \to c$

$$I_3 (4R) - I_4 (3R) = 0$$

$$\Rightarrow 4 I_3 - 3 I_4 = 0$$

④ Node C:

$$I_1 + I_2 = I_3 + I_4$$

$$\begin{cases} I_1 + 4I_3 = 250 \\ 2I_2 + 3I_4 = 500 \\ 4I_3 = 3I_4 \\ I_1 + I_2 = I_3 + I_4 \end{cases} \underset{\dots}{\Rightarrow} \begin{cases} I_1 = 10 \\ I_2 = 130 \\ I_3 = 60 \\ I_4 = 80 \end{cases}$$

Node A: $I_3 = I_1 + I$

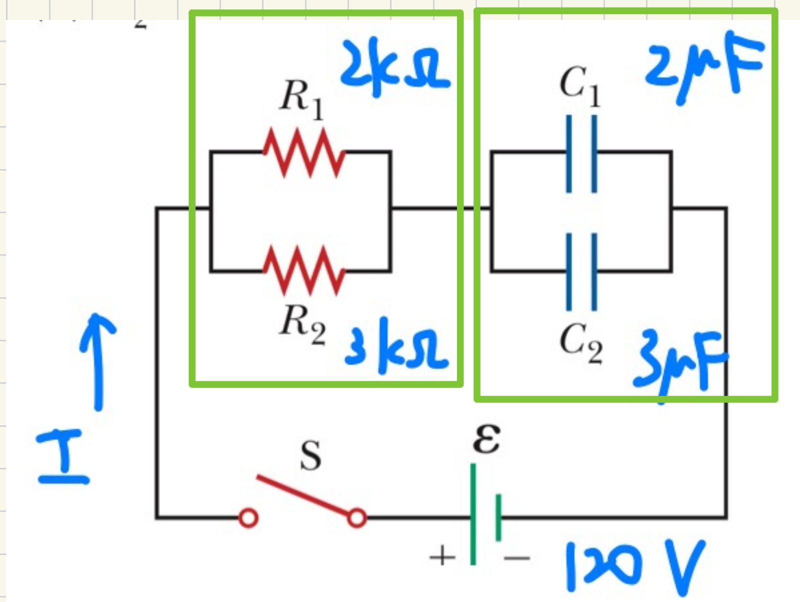
$$\Rightarrow |I| = |I_1 - I_3| = 50 \ (mA)$$

#

41.

$$R_{eq} = \frac{1}{\frac{1}{2} + \frac{1}{3}} = 1.2 \ (k\Omega)$$

$$Q = \frac{C}{\cancel{\Delta V}} \Rightarrow \begin{cases} Q \propto C \\ \Delta V = \frac{C}{Q} \end{cases}$$



An RC circuit w/

$$R = \frac{1}{\frac{1}{2} + \frac{1}{3}} = 1.2 \ (k\Omega)$$

$$C = 2 + 3 = 5 \ (\mu F)$$

$$V(t) = \varepsilon\left(1 - e^{-t/RC}\right)$$

$$= 120\left[1 - e^{-t/(1.2\times10^{3})(5\times10^{-6})}\right]$$

$$= 120\left[1 - e^{-t/(6\times10^{-3})}\right]$$

$$\left(C = \frac{Q}{\Delta V} \Rightarrow Q = C\Delta V \right)$$

$$\begin{cases} q_{c_1} = (2\times10^{-6})\,120\left[1 - e^{-t/(6\times10^{-3})}\right] \\ \quad = 2.4\times10^{-4}\left[1 - e^{-t/(6\times10^{-3})}\right] \\ q_{c_2} = (3\times10^{-6})\,120\left[1 - e^{-t/(6\times10^{-3})}\right] \end{cases}$$

$$= 3.6\times10^{-4}\left[1 - e^{-t/(6\times10^{-3})}\right]$$

#