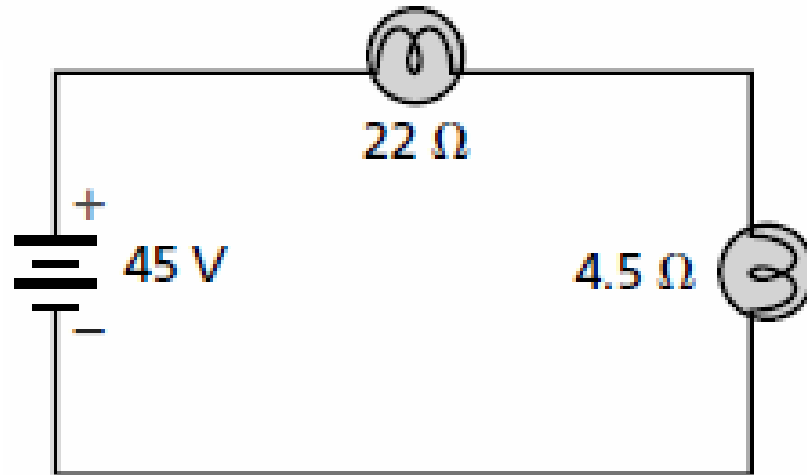


PQ 14 Electricity Circuits

Q and A

Q1

A $22\text{-}\Omega$ lamp and a $4.5\text{-}\Omega$ lamp are connected in series and placed across a potential difference of 45 V as shown



- a. What is the equivalent resistance of the circuit?

$$22\ \Omega + 4.5\ \Omega = 26.5\ \Omega$$

- b. What is the current in the circuit?

$$I = \frac{V}{R} = \frac{45\text{ V}}{26.5\ \Omega} = 1.7\text{ A}$$

- c. What is the voltage drop across each lamp?

$$V = IR = (1.7\text{ A})(22\ \Omega) = 37.4\text{ V}$$

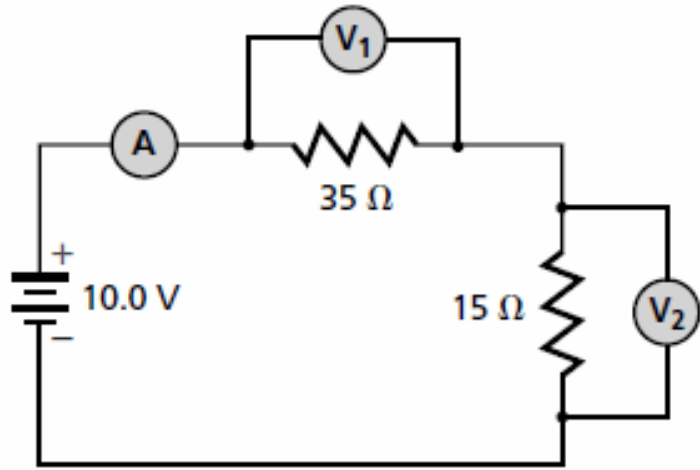
$$V = IR = (1.7\text{ A})(4.5\ \Omega) = 7.65\text{ V}$$

- d. What is the power dissipated in each lamp?

$$P = IV = (1.7\text{ A})(37.4\text{ V}) = 63.58\text{ W}$$

$$P = IV = (1.7\text{ A})(7.65\text{ V}) = 12.99\text{ W}$$

Q2



a. What should the ammeter read?

$$R = R_1 + R_2 = 35 \, \Omega + 15 \, \Omega$$

$$I = V/R$$

$$= (10.0 \, \text{V}) / (35 \, \Omega + 15 \, \Omega)$$

$$= 0.20 \, \text{A}$$

b. What should voltmeter 1 read?

$$V = IR = (0.20 \, \text{A})(35 \, \Omega) = 7.0 \, \text{V}$$

c. What should voltmeter 2 read?

$$V = IR = (0.20 \, \text{A})(15 \, \Omega) = 3.0 \, \text{V}$$

d. How much energy is supplied by the battery per minute?

$$E = Pt$$

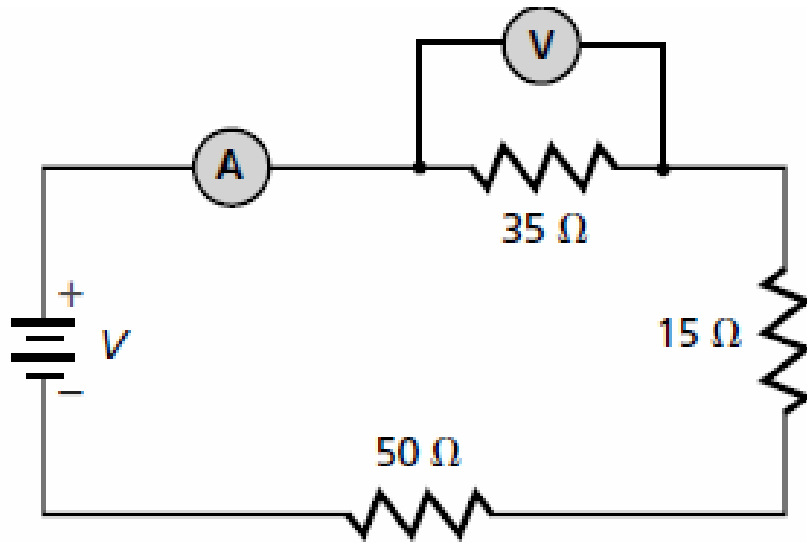
$$= VIt$$

$$= (10.0 \, \text{V})(0.20 \, \text{A})(1 \, \text{min})(60 \, \text{s/min})$$

$$= 120 \, \text{J}$$

Q3

- The voltmeter reads 70.0 V.



- a. Which resistor is the hottest?

$50\ \Omega$. Since $P = I^2R$ and I is constant in a series circuit, the largest value of resistance will produce the most power.

- b. Which resistor is the coolest?

$15\ \Omega$. Since $P = I^2R$ and I is constant in a series circuit, the smallest value of resistance will produce the least power.

- c. What will the ammeter read?

$$\begin{aligned} \text{Use Ohm's law: } I &= V/R \\ &= (70.0\ \text{V})/(35\ \Omega) \\ &= 2.0\ \text{A} \end{aligned}$$

- d. What is the power supplied by the battery?

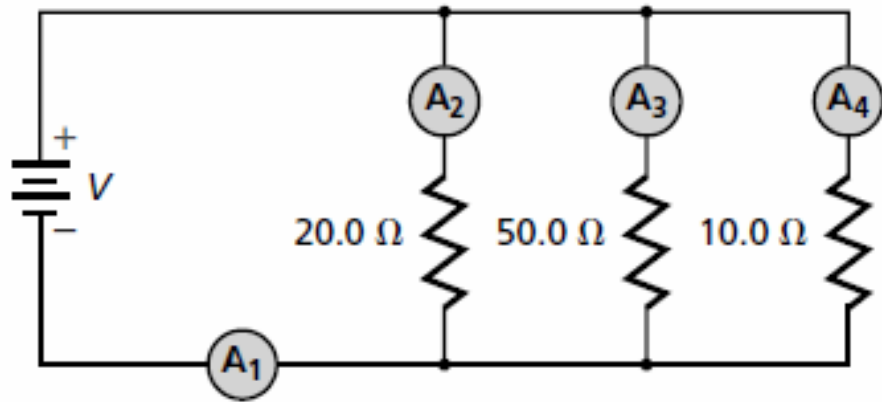
First, find the total resistance:

$$\begin{aligned} R &= R_1 + R_2 + R_3 \\ &= 35\ \Omega + 15\ \Omega + 50\ \Omega \\ &= 0.1\ \text{k}\Omega \end{aligned}$$

$$\begin{aligned} P &= I^2R \\ &= (2.0\ \text{A})^2(0.1\ \text{k}\Omega)(1000\ \Omega/\text{k}\Omega) \\ &= 4 \times 10^2\ \text{W} \end{aligned}$$

Q4

- The battery develops 110 V.



- a. Which resistor is the hottest?
10.0 Ω. Since $P = V^2/R$ and V is constant in a parallel circuit, the smallest resistor will dissipate the most power.
- b. Which resistor is the coolest?
50.0 Ω. Since $P = V^2/R$ and V is constant in a parallel circuit, the largest resistor will dissipate the least power.

- c. What will ammeter 1 read?

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$R = \frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)}$$

$$= \frac{1}{\left(\frac{1}{20.0 \Omega} + \frac{1}{50.0 \Omega} + \frac{1}{10.0 \Omega}\right)}$$

$$= 5.88 \Omega$$

$$I = \frac{V}{R} = \frac{1.1 \times 10^2 \text{ V}}{5.88 \Omega} = 19 \text{ A}$$

- d. What will ammeter 2 read?

$$I = \frac{V}{R} = \frac{1.1 \times 10^2 \text{ V}}{20.0 \Omega} = 5.5 \text{ A}$$

- e. What will ammeter 3 read?

$$I = \frac{V}{R} = \frac{1.1 \times 10^2 \text{ V}}{50.0 \Omega} = 2.2 \text{ A}$$

- f. What will ammeter 4 read?

$$I = \frac{V}{R} = \frac{1.1 \times 10^2 \text{ V}}{10.0 \Omega} = 11 \text{ A}$$

Q5

The load across a battery consists of two resistors, with values of $15\ \Omega$ and $47\ \Omega$, connected in series.

a. What is the total resistance of the load?

$$\begin{aligned} R &= R_1 + R_2 = 15\ \Omega + 47\ \Omega \\ &= 62\ \Omega \end{aligned}$$

b. What is the voltage of the battery if the current in the circuit is $97\ \text{mA}$?

$$V = IR = (97\ \text{mA})(62\ \Omega) = 6.0\ \text{V}$$

Q6

A $16.0\text{-}\Omega$ and a $20.0\text{-}\Omega$ resistor are connected in parallel. A difference in potential of 40.0 V is applied to the combination.

- a. Compute the equivalent resistance of the parallel circuit.

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\begin{aligned} R &= \frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2}\right)} \\ &= \frac{1}{\left(\frac{1}{16.0\ \Omega} + \frac{1}{20.0\ \Omega}\right)} \\ &= 8.89\ \Omega \end{aligned}$$

- b. What is the total current in the circuit?

$$I = \frac{V}{R} = \frac{40.0\ \text{V}}{8.89\ \Omega} = 4.50\ \text{A}$$

- c. What is the current in the $16.0\text{-}\Omega$ resistor?

$$I_1 = \frac{V}{R_1} = \frac{40.0\ \text{V}}{16.0\ \Omega} = 2.50\ \text{A}$$

Q7

- a. Determine the total resistance.

The 30.0- Ω and 20.0- Ω resistors are in series.

$$R_1 = 30.0 \Omega + 20.0 \Omega = 50.0 \Omega$$

The 10.0- Ω and 40.0- Ω resistors are in series.

$$R_2 = 10.0 \Omega + 40.0 \Omega = 50.0 \Omega$$

R_1 and R_2 are in parallel.

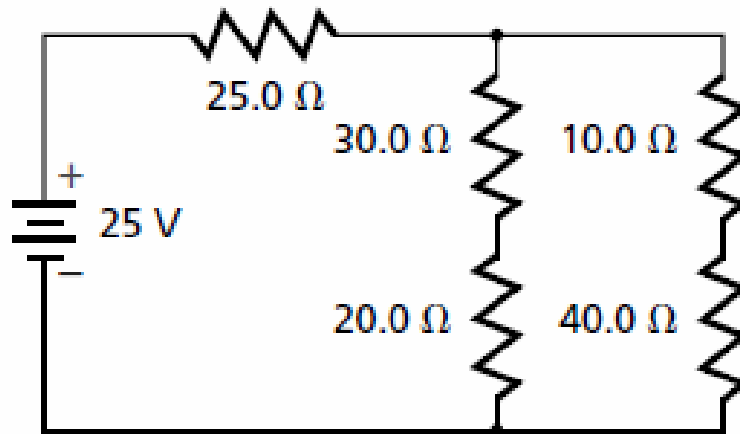
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R = \frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2}\right)}$$

$$= \frac{1}{\left(\frac{1}{50.0 \Omega} + \frac{1}{50.0 \Omega}\right)}$$

= 25.0 Ω and is in series with the 25.0- Ω resistor

$$R_{\text{Total}} = 25.0 \Omega + 25.0 \Omega = 50.0 \Omega$$



- b. Determine the current through the 25- Ω resistor.

use Ohm's law and R_{Total}

$$I = \frac{V}{R_{\text{Total}}} = \frac{25 \text{ V}}{50.0 \Omega} = 0.50 \text{ A}$$

- c. Which resistor is the hottest? Coolest?

$$P = I^2 R = (0.50 \text{ A})^2 (25.0 \Omega) = 6.25 \text{ W}$$

Q8

A circuit contains six 60-W lamps with a resistance of $240\text{-}\Omega$ each and a $10.0\text{-}\Omega$ heater connected in parallel. The voltage across the circuit is 120 V . Find the current in the circuit for the following situations.

a. Four lamps are turned on.

$$\begin{aligned}\frac{1}{R} &= \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \\ &= \frac{1}{240\ \Omega} + \frac{1}{240\ \Omega} + \frac{1}{240\ \Omega} + \\ &\quad \frac{1}{240\ \Omega} \\ &= \frac{4}{240\ \Omega} \\ R &= \frac{240\ \Omega}{4} = 0.060\ \text{k}\Omega \\ I &= \frac{V}{R} = \frac{120\ \text{V}}{0.060\ \text{k}\Omega} = 2.0\ \text{A}\end{aligned}$$

b. All of the lamps are turned on.

$$\begin{aligned}\frac{1}{R} &= \frac{6}{240\ \Omega} \\ R &= \frac{240\ \Omega}{6} = 0.040\ \text{k}\Omega \\ I &= \frac{V}{R} = \frac{120\ \text{V}}{0.040\ \text{k}\Omega} = 3.0\ \text{A}\end{aligned}$$

c. Six lamps and the heater are operating.

$$\begin{aligned}\frac{1}{R} &= \frac{1}{0.040\ \text{k}\Omega} + \frac{1}{10.0\ \Omega} \\ &= \frac{5}{4.0 \times 10^1\ \Omega} \\ R &= \frac{4.0 \times 10^1\ \Omega}{5} = 8.0\ \Omega \\ I &= \frac{V}{R} = \frac{120\ \text{V}}{8.0\ \Omega} = 15\ \text{A}\end{aligned}$$