d)

$$I = \frac{q}{t}$$
$$q = It$$
$$= (12.5\text{ A})\left(15\text{ min} \times \frac{60\text{ s}}{1\text{ min}}\right)$$
$$= 1.1 \times 10^4\text{ C}$$
$$\#e^- = \frac{\text{total charge}}{\text{charge/e}^-}$$
$$= \frac{1.1 \times 10^4\text{ C}}{1.60 \times 10^{-19}\text{ C}}$$
$$= 7.0 \times 10^{22}$$

15.

$$V = \frac{\Delta E}{q}$$
$$\Delta E = qV$$
$$= (2.4 \times 10^3\text{ C})(120\text{ V})$$
$$= 2.9 \times 10^5\text{ J}$$

Lesson 3—Electric Circuits

1. In a series circuit:

$$I_T = I_1 = I_2 = I_3$$
$$I_1 = 1.7\text{ A}$$
$$I_2 = 1.7\text{ A}$$
$$I_3 = 1.7\text{ A}$$

2. In a parallel circuit:

$$I_T = I_1 + I_2$$
$$I_T = 2.1\text{ A} + 1.5\text{ A}$$
$$= 3.6\text{ A}$$

In a series circuit:

$$I_T = I_3$$
$$I_3 = 3.6\text{ A}$$

3. In a series circuit:

$$V_T = V_1 + V_2$$
$$12.0\text{ V} = 8.0\text{ V} + V_2$$
$$V_2 = 4.0\text{ V}$$

4. In a parallel circuit:

$$V_T = V_1 = V_2$$
$$20.0\text{ V} = 20.0\text{ V} = V_2$$
$$V_2 = 20.0\text{ V}$$

5. In a series circuit:

$$V_T = V_1 + (V_2 + V_3)$$
$$45.0\text{ V} = 11.0\text{ V} + (V_2 + V_3)$$
$$V_2 + V_3 = 45.0\text{ V} - 11.0\text{ V}$$
$$= 34.0\text{ V}$$

In a parallel circuit:

$$V_T = V_2 = V_3$$
$$34.0\text{ V} = V_2 = V_3$$
$$V_2 = 34.0\text{ V}$$
$$V_3 = 34.0\text{ V}$$

6. In a series circuit:

$$R_T = R_1 + R_2$$
$$= 15.0\ \Omega + 20.0\ \Omega$$
$$= 35.0\ \Omega$$

7. In a parallel circuit:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$= \frac{1}{6.0\ \Omega} + \frac{1}{8.0\ \Omega}$$
$$R_T = 3.4\ \Omega$$

8. In a parallel circuit:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$
$$= \frac{1}{3.0\ \Omega} + \frac{1}{6.0\ \Omega}$$
$$R_T = 2.0\ \Omega$$

In a series circuit:

$$R_T = R_1 + \left(\frac{1}{R_2} + \frac{1}{R_3}\right)$$
$$= 2.0\ \Omega + 2.0\ \Omega$$
$$= 4.0\ \Omega$$

9.

$$R_T = R_1 + R_2 + R_3$$
$$= 9.0\ \Omega + 3.0\ \Omega + 12.0\ \Omega$$
$$= 24.0\ \Omega$$

10. In a parallel circuit:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$
$$= \frac{1}{2.0\ \Omega} + \frac{1}{4.0\ \Omega} + \frac{1}{8.0\ \Omega}$$
$$R_T = 1.1\ \Omega$$

11. In a parallel circuit:

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

$$\frac{1}{2.0\ \Omega}=\frac{1}{4.5\ \Omega}+\frac{1}{9.0\ \Omega}+\frac{1}{R_3}$$

$$\frac{1}{R_3}=\frac{1}{2.0\ \Omega}-\left(\frac{1}{4.5\ \Omega}+\frac{1}{9.0\ \Omega}\right)$$

$$R_3=6.0\ \Omega$$

12. In a series circuit:

$$\begin{aligned}R_T &= R_1 + R_2 + R_3\\ 12.0\ \Omega &= 6.0\ \Omega + 4.0\ \Omega + R_3\end{aligned}$$

$$\begin{aligned}R_3 &= 12.0\ \Omega - 10.0\ \Omega\\ &= 2.0\ \Omega\end{aligned}$$

13. a) In a series circuit:

$$\begin{aligned}R_T &= R_1 + R_2\\ &=10.0\ \Omega+15.0\ \Omega\\ &= 25.0\ \Omega\end{aligned}$$

$$\begin{aligned}I_T &=\frac{V_T}{R_T}\\ &=\frac{30.0\ \text{V}}{25.0\ \Omega}\\ &=1.20\ \text{A}\end{aligned}$$

$$I_T = I_1 = I_2$$

$$I_1 =1.20\ \text{A}$$

$$I_2 =1.20\ \text{A}$$

b)

$$\begin{aligned}P&=I^2R_1\\ &=(1.20\ \text{A})^2(10.0\ \Omega)\\ &=14.4\ \text{W}\end{aligned}$$

14. a) In a parallel circuit:

$$\begin{aligned}\frac{1}{R_T}&=\frac{1}{R_1}+\frac{1}{R_2}\\ &=\frac{1}{6.0\ \Omega}+\frac{1}{3.0\ \Omega}\end{aligned}$$

$$R_T = 2.0\ \Omega$$

$$V_T =15.0\ \text{V}$$

$$\begin{aligned}I_T &=\frac{V_T}{R_T}\\ &=\frac{15.0\ \text{V}}{2.0\ \Omega}\\ &=7.5\ \text{A}\end{aligned}$$

b)

$$\begin{aligned}I_1 &=\frac{7.5\ \text{A}}{3}\\ &= 2.5\ \text{A}\end{aligned}$$

$$\begin{aligned}P&= I_2R\\ &=(2.5\ \text{A})^2(6.0\ \Omega)\\ &= 38\ \text{W}\end{aligned}$$

15. a) In a parallel circuit:

$$\begin{aligned}\frac{1}{R_T}&=\frac{1}{R_1}+\frac{1}{R_2}\\ &=\frac{1}{6.0\ \Omega}+\frac{1}{8.0\ \Omega}\end{aligned}$$

$$R_T =3.5\ \Omega$$

In the second circuit:

$$\begin{aligned}I_2 &=\frac{V_2}{R_2}\\ &=\frac{12.0\ \text{V}}{8.0\ \Omega}\\ &=1.5\ \text{A}\end{aligned}$$

$$\begin{aligned}I_1 &=\frac{V_T}{R_T}\\ &=\frac{12.0\ \text{V}}{3.5\ \Omega}\\ &=3.5\ \text{A}\end{aligned}$$

b)

$$\begin{aligned}P&= I^2R\\ &=(3.5\ \text{A})^2(3.5\ \Omega)\\ &= 42\ \text{W}\end{aligned}$$

16. a) In the parallel circuits:

$$\begin{aligned}\frac{1}{R_T}&=\frac{1}{R_1}+\frac{1}{R_2}\\ &=\frac{1}{2.0\ \Omega}+\frac{1}{4.0\ \Omega}\end{aligned}$$

$$R_T =1.3\ \Omega$$

In the total circuit:

$$\begin{aligned}R_T &= R_{T(\text{parallel})} + R_1\\ &=1.3\ \Omega+6.0\ \Omega\\ &=7.3\ \Omega\end{aligned}$$

$$\begin{aligned}I_1 = I_3 &=\frac{V_T}{R_T}\\ &=\frac{20.0\ \text{V}}{7.3\ \Omega}\\ &= 2.7\ \text{A}\end{aligned}$$

To find the proportion of this current that passes through R_3, we will use a ratio:

$$I=\frac{V}{R} \quad \text{or} \quad I\alpha\frac{1}{R}$$

$$\frac{R_3}{R_2} = \frac{4.0\ \Omega}{2.0\ \Omega} = 2.0$$

If the resistance R_3 is 2.0 times the resistance R_2, then the current through R_3 is 0.5 times the current through R_2.

$I_T = I_{R2} + I_{R3}$

Let I_2 = current through R_3.

$$\begin{aligned} 2.7\ \text{A} &= 2I_2 + I_2 \\ 3I_2 &= 2.7\ \text{A} \\ I_2 &= \frac{2.7\ \text{A}}{3} \\ &= 0.91\ \text{A} \end{aligned}$$

b)

$$\begin{aligned} P &= I^2R \\ &= (2.7\ \text{A})(7.3\ \Omega) \\ &= 55\ \text{W} \end{aligned}$$

17. a) In a series circuit:

$$\begin{aligned} R_T &= R_1 + R_2 + R_3 \\ &= 2.0\ \Omega + 2.5\ \Omega + 3.0\ \Omega \\ &= 7.5\ \Omega \\ V &= IR \\ &= (8.0\ \text{A})^2(7.5\ \Omega) \\ &= 6.0\times10^1\ \text{V} \end{aligned}$$

b)

$$\begin{aligned} P &= I^2R \\ &= (8.0\ \text{A})^2(7.5\ \Omega) \\ &= 4.8\times10^2\ \text{W} \end{aligned}$$

18. a) In a parallel circuit:

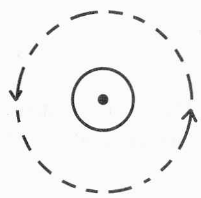
$$\begin{aligned} \frac{1}{R_T} &= \frac{1}{R_1} + \frac{1}{R_2} \\ &= \frac{1}{8.0\ \Omega} + \frac{1}{10.0\ \Omega} \\ R_T &= 4.4\ \Omega \\ I &= \frac{V}{R} \\ &= \frac{25.0\ \text{V}}{4.4\ \Omega} \\ &= 5.6\ \text{A} \end{aligned}$$

b)

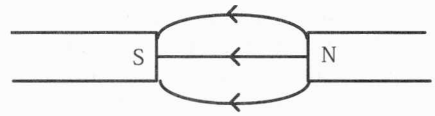
$$\begin{aligned} P &= I^2R \\ &= (5.6\ \text{A})^2(4.4\ \Omega) \\ &= 1.4\times10^2\ \text{W} \end{aligned}$$

Lesson 4—Magnetism

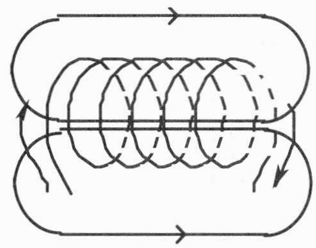
1. a)



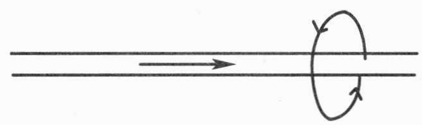
b)



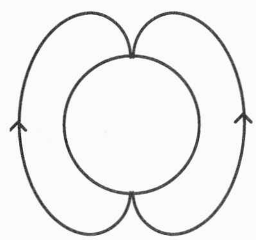
c)



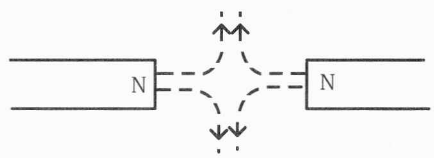
d)



e)



f)



2. a) $B\alpha = \frac{I}{r}$

$\therefore$ since r doubles, B will be $\frac{1}{2}$.

Magnetic field at $B = \frac{1}{2}(1.5\times10^{-2}\ \text{T})$

$= 7.5\times10^{-3}\ \text{T}$

b) $N = \mu_0 nI$, $\therefore$ if the current triples, the magnetic field triples.

c) $B = \mu nI$. Since the permeability (μ) increases 5 000 times, the magnetic field strength will increase 5 000 times.