Chapter 13

(Q5) 8 points  Consider the circuit shown, where the wires are connected to either side of a wooden block as well as to the light bulb. Will the bulb light in this arrangement? Explain.

Since the circuit is not complete, no charge will flow and the bulb will not light.

(Q10) 8 points  If we decrease the potential difference across a resistance in a circuit, will the current flowing through that resistance increase, remain the same, or decrease? Explain.

The potential difference across a resistance is given by $\Delta V = IR$. Therefore, by decreasing this potential difference, we also decrease the current directed through the resistance.

(Q14) 10 points  In the circuit shown below, $R_1$, $R_2$, and $R_3$ are three resistors of different values. $R_3$ is greater than $R_2$, and $R_2$ is greater than $R_1$. $\varepsilon$ is the electromotive force of the battery whose internal resistance is negligible. Which of the three resistors has the greatest current flowing through it? Explain.

Resistors $R_1$ and $R_2$ are in parallel, so only a fraction of the total current is directed across either. Resistor $R_3$, however, is in series with this combination. As a result, the entire current is directed across this resistor, so $R_3$ has the greatest current.

(Q22) 8 points  If the current through a certain resistance is doubled, does the power dissipated in that resistor also double? Explain.

No. The power dissipated in a resistor is given by $P = I^2R$. Therefore, doubling the current increases the power by a factor of four.

(E2) 8 points  A current of 2.5 A flows through a battery for 1 min. How much charge passes through the battery in that time?

Using $I = \Delta Q/\Delta t$ and solving for $\Delta Q$, we find that

$$\Delta Q = I\Delta t = (2.5 \text{ A})(60 \text{ s}) = 150 \text{ C}.$$ 

(E10) 10 points  Two resistors, each having a resistance of 8 $\Omega$, are connected in parallel. What is the equivalent resistance of this combination?

For resistors in parallel, $1/R_{eq} = 1/R_1 + 1/R_2$. Solving for the equivalent resistance $R_{eq}$, we find that

$$R_{eq} = \frac{R_1R_2}{R_1 + R_2} = \frac{(8 \Omega)(8 \Omega)}{8 \Omega + 8 \Omega} = 4 \Omega.$$ 

(E14) 10 points  A 30 – $\Omega$ resistor has voltage difference of 3 V across its leads.

a. What is the current through the resistor?

Using $\Delta V = IR$ and solving for $I$ we find that

$$I = \frac{\Delta V}{R} = \frac{3 \text{ V}}{30 \Omega} = 0.1 \text{ A}.$$ 

b. What is the power being dissipated in this resistor?

The power dissipated in this resistor is

$$P = I^2R = (0.1 \text{ A})^2(30 \Omega) = 0.3 \text{ W}.$$
Is the force exerted by one current-carrying wire on another due to electrostatic effects or not magnetic effect? Explain.

Both wires are electrically uniform and electrically neutral. As a result, the electrostatic force exerted by one wire on another is zero. Therefore, the force exerted by one current-carrying wire on another is due to magnetic effects.

If we were to represent the current loop of question 15 as a bar magnetic or magnetic dipole, in what direction would the north pole be pointing? Explain.

Using the right-hand rule, we find that the north pole would be pointing downward.

If Faraday would enough turns of wire on the secondary coil of his iron ring, would he have found that a large steady-state current in the primary coil induced a current in the secondary coil? Explain.

Faraday’s law states that a changing magnetic field induces an electric field. In order to induce a current in the secondary coil, the magnetic field produced by the current in the primary coil must be changing (typically, this is accomplished using an alternating current). Therefore, a steady-state (constant) current in the primary coil is not capable of inducing a current in the secondary coil.

A particle with a charge of 0.06 C is moving at right angles to a uniform magnetic field with a strength of 0.5 T. The velocity of the charge is 600 m/s. What is the magnitude of the magnetic force exerted on the particle?

The magnitude of the magnetic force exerted on the particle is

\[ F = qvB \sin \theta = (0.06 \text{ C})(600 \text{ m/s})(0.5 \text{ T}) \sin(90^\circ) = 18 \text{ N}. \]