1. An unknown resistor is connected between the terminals of a 8 V battery. Energy is
dissipated in the resistor at the rate of 16 watts. The same resistor is then connected between the
terminals of a 6 V battery. At what rate is energy now dissipated?

\[ P = \frac{V^2}{R} \]

\[ R = \frac{V^2}{P} = \frac{8^2}{16} = 4 \Omega \]

\[ P = \frac{V^2}{R} = \frac{6^2}{4} = 9 \text{ watts} \]

2. The current in a single-loop circuit with one resistance R is 7 A. When an additional
resistance of 2 Ω is inserted in series with R, the current drops to 5 A. What is R?

\[ \varepsilon = 7R \]

\[ \varepsilon = 5R + (5)(2) \]

\[ 7R = 5R + 10 \]

\[ R = 5 \Omega \]
3. In the circuit shown below:

a. What is the current flowing through the 5 Ω resistor and which direction is it going (left to right or right to left)?
b. What is ε₁?
c. What is ε₂?

\[ a) \text{ Junction A has 1A in from top + 2A out bottom} \]
\[ \Rightarrow \text{middle loop has 1A in (i.e. right to left)} \]

\[ b) \text{ loop } ① \text{ cc around top} \]
\[ +20 - (7)(1) - ε₁ + (5)(1) = 0 \]
\[ ε₁ = 18 \text{ V} \]

\[ c) \text{ loop } ② \text{ cc around outside} \]
\[ +20 - (7)(1) - (3)(2) - ε₂ = 0 \]
\[ ε₂ = 7 \text{ V} \]
4. A particle with a charge of 10 C and mass 40 kg is accelerated through a potential difference of 50 V. This particle then enters a uniform magnetic field of $B = 4 \, \text{T}$ perpendicular to its velocity.

a. What is the speed of the particle?

b. What is the radius of the resulting circular motion?

c. What is the period of revolution?

d. If the particle is travelling left to right in the plane of the test paper and the magnetic field is pointing perpendicular to the paper away from you, will the particle rotate clockwise or counterclockwise?

\[ a) \quad qV = \frac{1}{2} m v^2 \]
\[ \uparrow \quad \text{velocity} \]
\[ \operatorname{vetto} \quad \text{velocity} \]
\[ v = \sqrt{\frac{2qV}{m}} = \sqrt{\frac{(10)(50)}{40}} = \sqrt{25} = 5 \, \text{m/s} \]

\[ b) \quad R = \frac{mv}{qB} = \frac{(40)(5)}{(10)(4)} = 5 \, \text{m} \]

\[ c) \quad T = \frac{2\pi R}{v} = \frac{2\pi \times 5}{8} = \frac{2\pi (40)}{(10)(4)} = 2\pi \, \text{s} \]

\[ d) \quad \vec{B} \quad \vec{V} \times \vec{B} \text{ direction is up} \]
\[ \Rightarrow \text{counterclockwise} \]

\[ \Rightarrow \text{clockwise} \]
5. A metal wire of mass 6 kg can slide with negligible friction on two horizontal parallel rails separated by a distance \( d = 4 \) m. The track lies in a vertical uniform magnetic field of magnitude \( B = 10 \) T. At \( t = 0 \), device \( G \) is connected to the rail producing a constant current \( i = 12 \) A in the wire and rails. At \( t = 3 \) s:

a. What is the speed of the wire?

b. Is the wire moving left to right or right to left?

\[ F = I \times L \times B \]

\[ |F| = I \times L \times B = (12)(4)(10) = 480 \text{ N} \]

\[ a = \frac{F}{m} = \frac{480}{6} = 80 \text{ m/s}^2 \]

\[ v_t = v_i + at = (80)(3) = 240 \text{ m/s} \]

b) \( \vec{L} \times \vec{B} \) direction is left

\[ \Rightarrow \text{ Right to left} \]
6. A solid pipe of radius 4 m has a current of 48 A passing into the page as shown. According to Ampere's law $\oint B \cdot ds = \mu_0 I_{\text{enclosed}}$. We are interested in finding the magnetic field on the dashed circle which has a radius of 2 m.

a. What is the direction of the magnetic field at 2 m from the center of the circle?

b. What is $I_{\text{enclosed}}$ for this circle?

c. What is the magnitude of the magnetic field 2 m from the center of the circle (leave your answer in terms of $\mu_0$ and $\pi$ treated as constants without units).

![Diagram of a solid pipe with a current passing into the page and a dashed circle with a radius of 2 m.]

\[ \begin{align*}
\text{a)} & \quad \text{thumb into page} \\
\Rightarrow & \quad \text{current clockwise}
\end{align*} \]

\[ b) \quad I_{\text{enclosed}} = I \frac{\pi r^2}{\pi (4)^2} = 48 \frac{2^2}{4^2} = 12 \, \text{A} \]

\[ c) \quad \int B \cdot ds = \int B \cos 0^\circ \, ds = \mu_0 (12) \]

\[ B \int ds = 12 \mu_0 \]

\[ 2\pi (r = 2) \]

\[ 4\pi = 12 \mu_0 \]

\[ B = \frac{3 \mu_0}{\pi} \, \text{T} \]