1. At what temperature would the resistance of copper be double its resistance at 20° C (assume that the shape and length does not change)?

\[ R(T) = R_0 \left[ 1 + \alpha (T-T_0) \right] \]

\[ 2R_0 = R_0 \left[ 1 + \alpha (T-T_0) \right] \]

\[ \Rightarrow T = T_0 + \frac{l}{\alpha} \]

\[ = 20° C + \frac{1}{4.3 \times 10^{-3}} = 252,6° C \]

2. In the circuit shown below:

a. What is the equivalent resistance for the 3 resistors (4 points)?

b. How much current is coming out of the battery (3 points)?

c. How much current is passing through the 12 Ω resistor (3 points)?

\[ a) \text{ Parallel } \quad \frac{1}{R_p} = \frac{1}{6} + \frac{1}{12} \Rightarrow R_p = 4 \Omega \]

\[ \text{ Series } \quad R_{T_0-T} = 2\Omega + 4\Omega = 6\Omega \]

\[ b) \quad I = \frac{V}{R} = \frac{36V}{6\Omega} = 6 \text{ Amps} \]

\[ c) \quad \text{Parallel Voltage } \quad V_p = I R_p = (6)(4) = 24 \text{ Volts} \]

\[ I = \frac{V}{R} = \frac{24}{12} = 2 \text{ Amps} \]
3. In the figure shown below:
   a. What is the current following through the middle branch and what direction is it going? (5 points)
   b. What is the voltage of ε? (5 points)

   ![Figure with electrical circuit diagram]
   
   a) Junction A 6 A in ⇒ 6 amps out
      ⇒ 4 A left to right
   
   b) Top loop
      + 4 A - 6 A - ε - 4 A = 0
      ε = 10 V

4. A negative particle has a charge of -5.6 C and a mass of 3 kg. It is accelerated from rest through a potential difference of 6 volts which gives it a velocity moving from left to right as shown in the figure. It then enters a 9 T magnetic field pointing into the page.
   a. What speed is it going after the acceleration? (3 points)
   b. Is the resulting circular motion clockwise or counterclockwise? (3 points)
   c. What is the radius of the circle? (4 points)

   ![Magnetic field diagram]
   
   a) \( \frac{1}{2} m v^2 = |\text{charge}| \times \text{Vels} = (5.6)(6) \)
      \( v^2 = \frac{(5.6)(6)}{(3)} \)
      \( v = 4.7 \text{ m/s} \)

   b) \( \overline{V} \times \overline{B} \) is up
      \( F = g \overline{V} \times \overline{B} \) is down
      \( \Rightarrow \) clockwise

   c) \( R = \frac{mv}{8B} \)
      \( R = \frac{(3)(4.7)}{(5.6)(9)} \)
      \( R = 0.28 \text{ m} \)
5. A 19.6 m long wire with a mass 12 kg is suspended by a pair of flexible leads as shown. There is a magnetic field of 3 T pointing out of the page.

a. What is the magnitude of the current required to remove the tension in the supporting leads? (7 points)
b. What is the direction of the current (left to right or right to left)? (3 points)

\[ mg = I L B \]
\[ I = \frac{mg}{LB} \]
\[ = \frac{(12)(9.8)}{(19.6)(3)} = 2 A \]

b) For B out of page, I must go right to left to get a repulsive force.

6. At a certain location in South Dakota, the earth’s magnetic field has a magnitude of 40 \( \mu \)T and it is pointing directly north. Suppose that the net field is zero exactly 0.126 m below a long, straight horizontal wire that carries a constant current.

a. What is the magnitude of the current? (7 points)
b. What direction is the current moving? (3 points)

a) To get 40 \( \mu \)T B

\[ B = \frac{\mu_0 I}{2\pi R} \]
\[ I = \frac{2\pi R B}{\mu_0} = \frac{2\pi (0.126) 40 \times 10^{-6}}{1.26 \times 10^{-6}} \]
\[ = 25 A \]

b) Need field to point South to cancel Earth’s North current from East to West gives South below