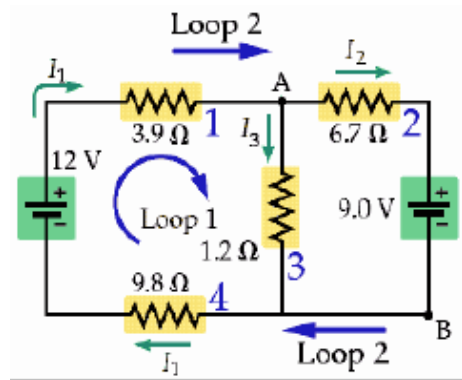
PHYSQ 126, Quiz 6
8 mars 2012

63. **Picture the Problem**: Four resistors and two batteries are connected as shown in the circuit diagram at right.



Strategy: The circuit can be analyzed by applying Kirchoff's rules. First apply the Junction Rule to point A in the circuit, then apply the Loop Rule to two loops, the left-hand loop 1 and the outside loop 2 labeled in the diagram. These three equations can be combined to algebraically find I_1, I_2, and I_3. From the currents we can find the potential difference between the points A and B.

Solution: 1. (a) Apply the Junction Rule to point A:

$$I_1 = I_2 + I_3 \ldots\ldots\text{(i)}$$

2. Apply the Loop Rule to loop 1, beginning in lower left-hand corner, and solve for I_3:

$$0 = 12\text{ V} - I_1R_1 - I_3R_3 - I_1R_4$$

$$I_3 = \frac{12\text{ V}}{R_3} - \frac{R_1+R_4}{R_3}I_1 = 10\text{ A} - \frac{13.7\ \Omega}{1.2\ \Omega}I_1 \ldots\ldots\text{(ii)}$$

3. Apply the Loop Rule to loop 2, beginning in lower left-hand corner, and solve for I_2:

$$0 = 12\text{ V} - I_1R_1 - I_2R_2 - 9.0\text{ V} - I_1R_4$$

$$I_2 = \frac{12.0 - 9.0\text{ V}}{R_2} - \frac{R_1+R_4}{R_2}I_1 = \left(\frac{3.0\text{ V}}{6.7\ \Omega}\right) - \left(\frac{13.7\ \Omega}{6.7\ \Omega}\right)I_1 \ldots\ldots\text{(iii)}$$

4. Substitute equations (ii) and (iii) into equation (i).

$$I_1 = 10\text{ A} - \left(\frac{13.7}{1.2}\right)I_1 + \left(\frac{3.0}{6.7}\text{ A}\right) - \left(\frac{13.7}{6.7}\right)I_1$$

$$\left(1 + \frac{13.7}{1.2} + \frac{13.7}{6.7}\right)I_1 = 10\text{ A} + \frac{3}{6.7}\text{ A}$$

$$I_1 = \frac{10\text{ A} + \frac{3}{6.7}\text{ A}}{1 + \frac{13.7}{1.2} + \frac{13.7}{6.7}} = \underline{\underline{0.72\text{ A}}}$$

5. Substitute I_1 into equations (ii) and (iii):

$$I_3 = 10\text{ A} - \frac{13.7}{1.2}(0.72\text{ A}) = \underline{\underline{1.8\text{ A}}}$$

$$I_2 = \left(\frac{3.0}{6.7}\text{ A}\right) - \frac{13.7}{6.7}(0.72\text{ A}) = \underline{\underline{-1.0\text{ A}}}$$

6. The currents through each resistor are as follows: 3.9 Ω, 9.8 Ω: 0.72 A; 1.2 Ω: 1.8 A; 6.7 Ω: 1.0 A.

7. The potential at point *A* is greater than that at point *B* because I_3 flows in the direction shown in the diagram and produces a potential drop across R_3.

8. Find the potential drop across R_3:

$$V_A - V_B = I_3R_3 = (1.8\text{ A})(1.2\ \Omega) = \boxed{2.2\text{ V}}$$

Insight: Because we obtained a negative value for I_2, it must be flowing in the direction opposite that indicated by the arrow in the circuit diagram.