Phy 122 – Assignment 4

A. 1.

a. To have the same current, they should be in series.

b. to have the same potential difference across them, they should be in parallel.

2.

(Note that no current flows through a capacitor.)

**loop 1:**

\[ +5V - (300 \, \Omega)I - (200 \, \Omega)I = 0 \]

\[ 5 - 500I = 0 \]

\[ 500I = 5 \quad I = \frac{5}{500} = 0.010 \, A \]

**loop 2:**

Voltage across capacitor

\[ V_c = (200 \, \Omega)I = 0 \]

\[ V_c = (200 \times 0.010 \, A) = 2.0 \, V \]

\[ C = \frac{q}{V} \Rightarrow q = CV = (3 \times 10^{-6} \, \text{F})(2.0 \, V) = 6.0 \times 10^{-6} \, \text{C} \]
B. 1. Less than: If R is the resistance of one, \( \frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{R} \rightarrow \frac{1}{R_{eq}} = \frac{2}{R} \rightarrow R_{eq} = \frac{R}{2} \\

2. Power = VI. Find the resistor’s voltage and current, then multiply them.

Apply point rule to P:
Total in = total out.
6.0 A = 4.0 A + I
I = 2.0 A

Apply loop rule to the loop shown at right:

\[
28 \, V - (6 \, \text{A})(3 \, \Omega) - V_R = 0 \\
28 - 18 = V_R \\
10 \, V = V_R \\
\]

\[
P = VI = (2 \, \text{A})(10 \, \text{V}) = \boxed{20.0 \, \text{W}}
\]
C.

Every term in the summation should be a voltage. The $I_2$ term has amps for its unit, not volts.

Loop around the outside of the circuit:

$$15 - 7I_1 - 10 = 0$$

Point Rule (point P):

$$I_1 + I_2 = 2\ a$$

$$0.714 + I_2 = 2\ a \Rightarrow I_2 = 1.286 \approx 1.29\ A$$

Loop $\#2$:

$$+E - I_2(2\ a) - (2\ a)(5\ a) = 0$$

$$E = (1.286)(2) + (2)(5) = 12.6\ V$$

D. 1. Every term in the summation should be a voltage. The $I_2$ term has amps for its unit, not volts.

2. Loop around the outside of the circuit:

$$2\ V - (I_1)(4\ \Omega) = 0$$

$$4\ I_1 = 2$$

$$I_1 = 2/4 = .500\ A$$

(An ideal ammeter has no resistance. It acts just like another piece of wire would, and so contributes nothing to the equation.)

Loop around the right half:

$$+5\ V - (I_2)(9\ \Omega) - 2V = 0$$

$$9\ I_2 = 3$$

$$I_2 = 3/9 = .333\ A$$
Point rule:

\[ I_1 = I_2 + I_3 \]

\[ .500 = .333 + I_3 \]

\[ I_3 = .167 \text{ A} \]

E. 1. Loop around the outside of the circuit:

\[ +12 \text{ V} - \text{ (resistor voltage) } + 6 \text{ V} = 0 \]

Resistor voltage = 18 V \text{ ans.}

(The rest of the circuit doesn’t matter.)

2.

\[ \begin{align*}
\text{Series: } 2R + R &= 3R \\
\text{Series: } 3R + 3R &= 6R
\end{align*} \]

So, the actual circuit is equivalent to this:

3R and 6R are in parallel:

\[ \frac{1}{R_{eq}} = \frac{1}{3R} + \frac{1}{6R} \]

\[ \frac{1}{R_{eq}} = \frac{2}{6R} + \frac{1}{6R} \]

\[ \frac{1}{R_{eq}} = \frac{3}{6R} \Rightarrow R_{eq} = \frac{6R}{3} = 2R \]

\[ V = I \left( R_{eq} \right) \]

\[ 9 = (2)(2R) \]

\[ 9 = 4R \]

\[ R = \frac{9}{4} = 2.25 \text{ } \Omega \]