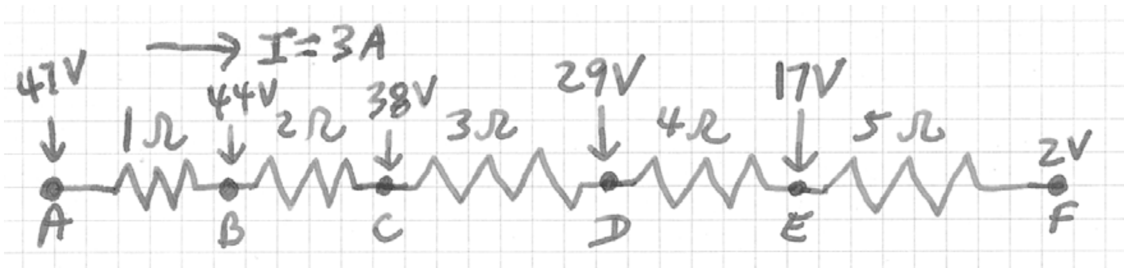
1. A piece of an electric circuit consists of five resistors connected as shown below. The electric potential at two points is shown.



(a) Determine the electric current in this part of the circuit and show its direction on the diagram.

Looking at the 4-Ω resistor, we see that its $\Delta V = 29$ V – 17 V = 12 V so the current through it is $I = \Delta V/R = (12\text{ V})/(4\ \Omega) = 3$ A. This is necessarily also the same current through all the other resistors.

(b) Fill out the $R - I - \Delta V$ table for these resistors:

R	I	ΔV
1 Ω	3 A	3 V
2 Ω	3 A	6 V
3 Ω	3 A	9 V
4 Ω	3 A	12 V
5 Ω	3 A	15 V

(c) Determine the electric potential at each of the other labeled points.

At F, $V = 17$ V – 15 V = 2 V
At C, $V = 29$ V + 9 V = 38 V
At B, $V = 38$ V + 6 V = 44 V
At A, $V = 44$ V + 3 V = 47 V

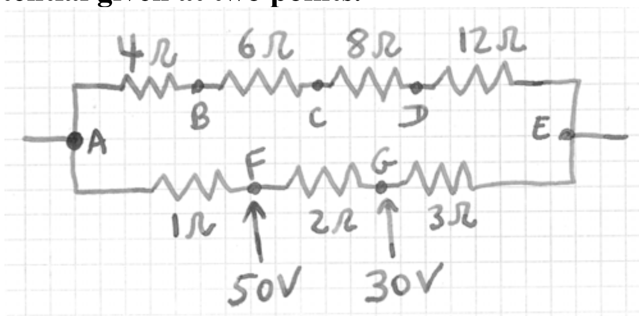
(d) What is the equivalent resistance R_{eq} of this part of the circuit?

The equivalent resistance $R = \Delta V/I$ = (47 V – 2 V)/(3 A) = 15 Ω

(e) Determine the value of IR_{eq} and identify the result with some potential difference you find on the circuit.

$IR_{eq} = (3\text{ A})(15\ \Omega) = 45$ V = the potential difference between points A and F at the ends of the circuit element.

2. Here is a more complicated piece of an electric circuit, with the resistances shown and the electric potential given at two points.



(a) Explain why there are only two different electric currents in this piece of circuit, and show where they flow, labeling them I_1 and I_2 in any way you want.

The same current must flow through the four resistors in the top branch; let's call that current I_1.

Similarly, the same current must flow through the three resistors in the bottom branch; let's call that current $I2$.

The two currents are not necessarily the same.

(b) Determine the values of the electric currents I_1 and I_2.

Start with what you can determine. The current I_2 in the lower branch is 10 A, as can be determined using the potential difference $\Delta V = 50\text{ V} - 30\text{ V} = 20\text{ V}$ and the resistance $R = 2\ \Omega$: $I_2 = (\Delta V)/R = (20\text{ V})/(2\Omega) = 10\text{ A}$. This current flows from left to right, in order for the potential at F to be greater than the potential at G, as shown.

Next, we can determine that the potential difference between points A and E must equal 60 V because the equivalent resistance is $1\ \Omega + 2\ \Omega + 3\ \Omega = 6\ \Omega$ and the current is $I_2 = 10\text{ A}$ so $\Delta V = IR = (10\text{ A})(6\ \Omega) = 60\text{ V}$.

This must be the same ΔV across the top branch, which has an equivalent resistance of $4\ \Omega + 6\ \Omega + 8\ \Omega + 12\ \Omega = 30\ \Omega$, so the current in the top branch is

$$I_1 = (\Delta V)/R = (60\text{ V})/(30\ \Omega) = 2\text{ A}.$$

This current also flows from left to right, from the higher potential at A to the lower potential at E.

(c) Label the electric potential at each of the labeled points on the circuit.

First work along the bottom branch to determine the potentials at A (60 V) and E (0 V), and then work along the top branch to determine the potentials at B (52 V), C (40 V), and D (24 V).

(d) Fill out the $R - I - \Delta V$ table for these resistors:

R	I	ΔV
1 Ω	10 A	10 V
2 Ω	10 A	20 V
3 Ω	10 A	30 V
4 Ω	2 A	8 V
6 Ω	2 A	12 V
8 Ω	2 A	16 V
12 Ω	2 A	24 V

(e) A separate table can be constructed for each branch of the circuit, in which the value of R is the equivalent resistance of that branch, I is the current in that branch, and ΔV is the potential difference between the end of the branch. Determne the table entries for the top and bottom branches:

	R	I	ΔV
top branch	30 Ω	2 A	60 V
bottom branch	6 Ω	10 A	60 V

(f) Finally, a single-row table can be constructed for this part of the circuit, in which I is the sum of the two currents and ΔV is the potential difference between the left and right ends of the circuit element. Fill it in and determine the entry for R. Does it bear any obvious relationship to the equivalent resistances of the two branches? (If you see one, specify it. If not, admit that there is no obvious relationship.)

R	I	ΔV
5 Ω	12 A	60 V

There is no obvious relationship. However, note that $1/(6\,\Omega) + 1/(30\,\Omega) = 1/(5\,\Omega)$.