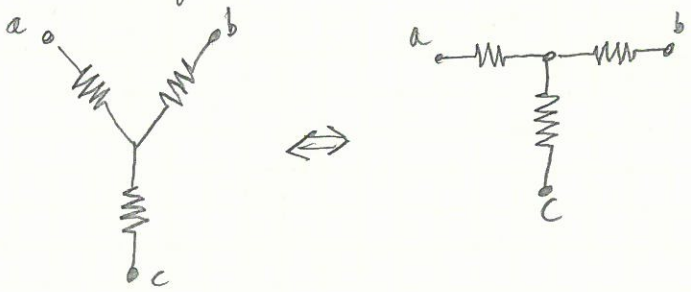
Cleaning up Circuit Schematics

We've been drawing circuit schematics with branches aligned to the horizontal and vertical axes. Real circuits, ie circuits made of real wires and physical components are usually not so neat. To analyze and debug real circuits we need to be able to draw an organized, easy-to-read schematic from the messy tangle of wires that we see in the lab.

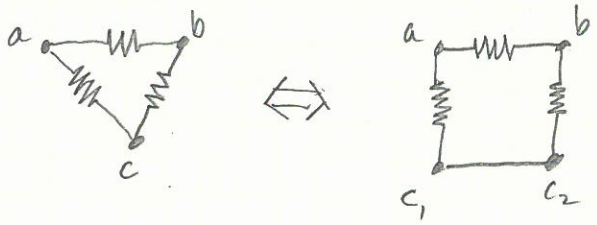
In these notes, we'll show by example, starting with simple circuits with just resistors. The topology is unchanged when other two-terminal elements are used. We label nodes only to help explain the transformation

Y-configuration

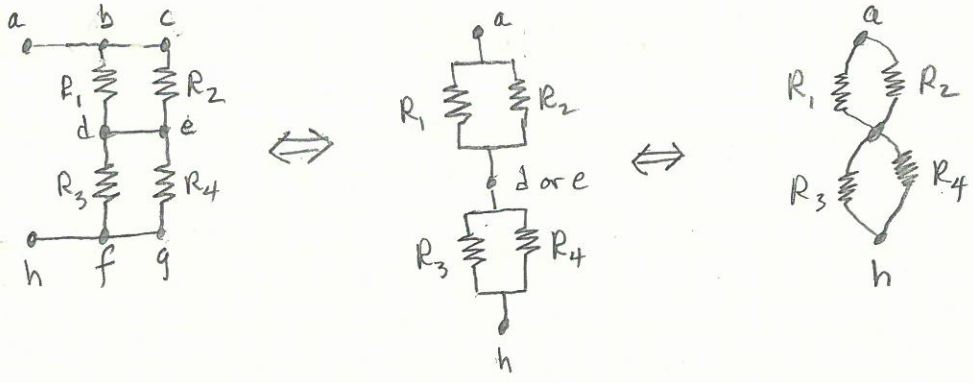


Transformation only requires "bending" the wires

Δ-configuration

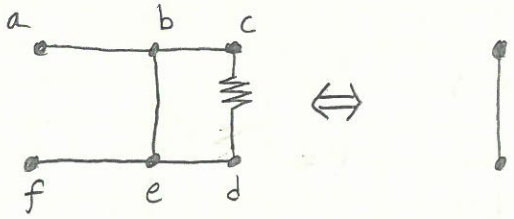


Transformation only involves adding an ideal wire between c_1 and c_2



Note if the wire between d and e is removed, the circuit is very different

A short circuit is a complete bypass

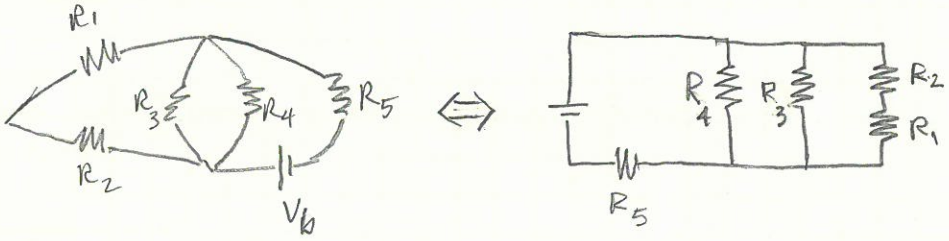


Proof: Compare to two resistors in parallel

$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$ if $R_1 = \emptyset$ or $R_2 = \emptyset$ then $R_{eq} = \emptyset$

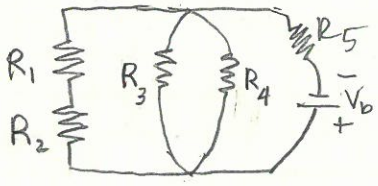
As long as the wire connecting nodes b and d has negligible resistance compared to the resistor, the magnitude of the resistor is irrelevant.

Real wires are not usually straight:

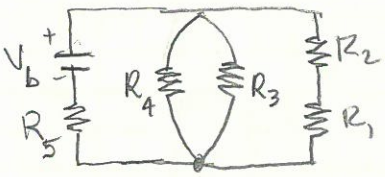


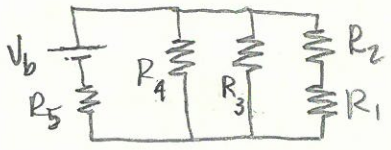
Sometimes it is helpful (or necessary) to make the transformation in steps

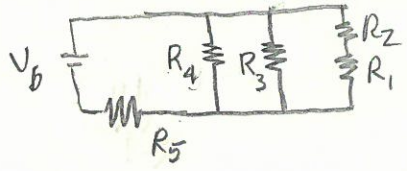
Start with the preceding circuit and gradually rearrange the circuit



Notice that the battery is upside down. Let's flip the circuit ↕ and then swap left-right







Don't be fixated on the numerical order of the subscripts. You can always renumber