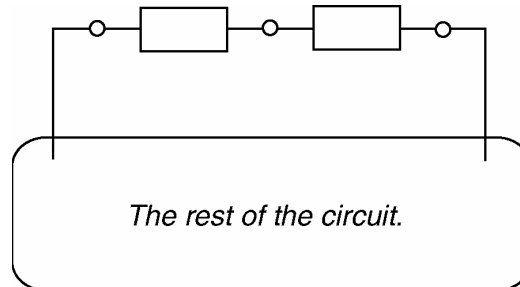


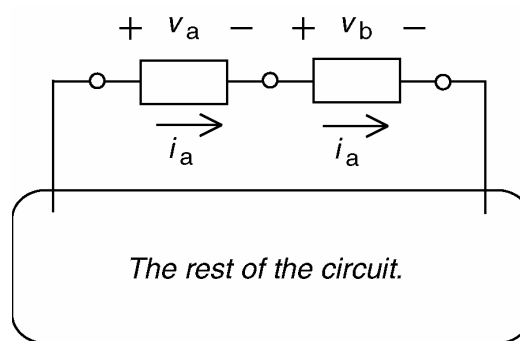
## Series and Parallel Circuit Elements

These two circuit elements are said to be connected in series:

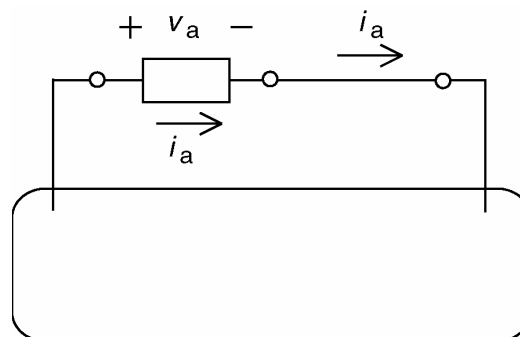


We notice that

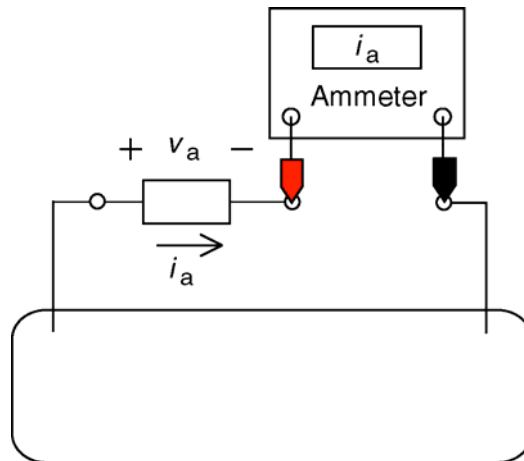
- The two elements are incident to a common node. That common node has degree equal to 2 (no other elements are incident to the common node).
- It is possible to label the element currents so that they are equal:



We can add a short circuit in series with any circuit element without changing the circuit.

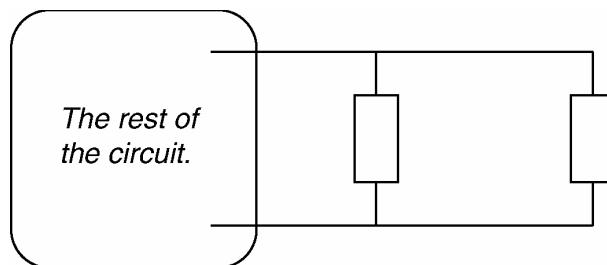


That short circuit is equivalent to an ideal ammeter. (The reference direction of the current determines the positions of the color-coded ammeter probes.)



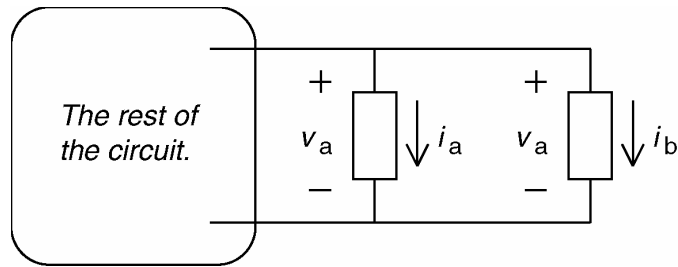
We can measure the current of any circuit element by adding an ammeter in series with that element. An ideal ammeter is equivalent to a short circuit and does not change the value of the current.

These two elements are said to be connected in parallel:

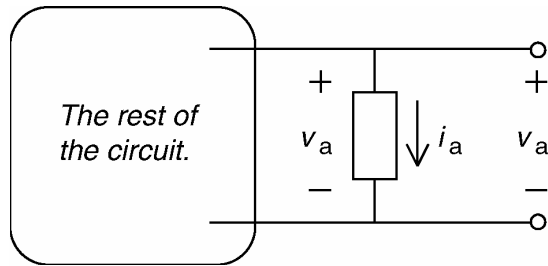


We notice that

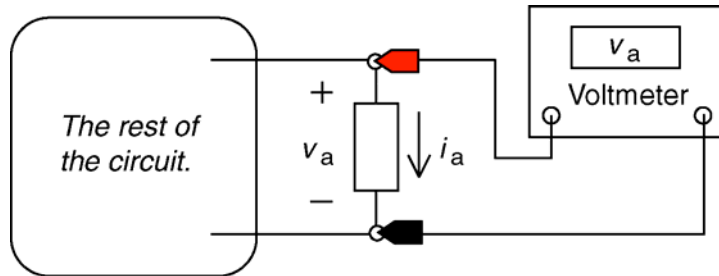
- The two elements are both incident to a pair of common nodes.
- It is possible to label the element voltages so that they are equal:



We can add an open circuit in parallel with any circuit element without changing the circuit.



That open circuit is equivalent to an ideal voltmeter. (The polarity of the voltage determines the positions of the color-coded voltmeter probes.)



We can measure the voltage of any circuit element by adding an voltmeter in parallel with that element. An ideal voltmeter is equivalent to an open circuit and does not change the value of the voltage.