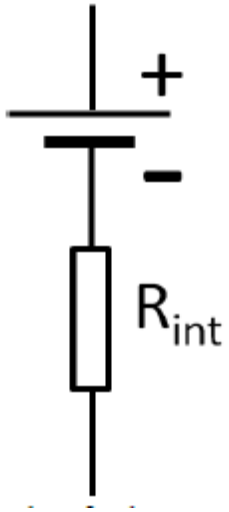
Homework 14.

Ideal and real voltage source.

We continue discussing ideal and real voltage sources
Just to remind, a real battery can be represented as the combination of ideal voltage source with zero resistance and resistor R_{int} connected in series.

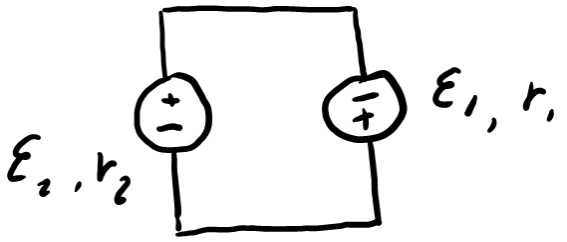


Now, if we will connect the terminals of a battery with a piece of wire (please do not do this – you will discharge the battery) the current in the wire will be limited by the internal resistance of the battery. The lower R_{int}, the more "powerful" is the battery and the more current it can provide. The voltage of the ideal voltage source "inside" the battery is called ***electromotive force*** (emf). In spite of the word "force" is used it is voltage and is measured in volts!

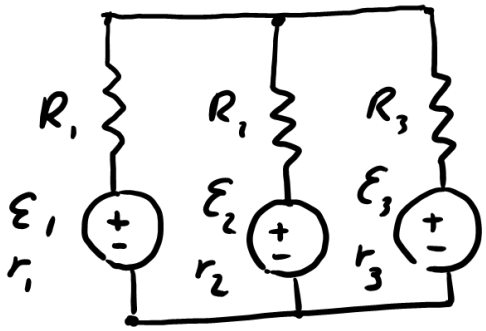
As we connect multiple batteries in series, we obtain a new voltage source with the emf and internal resistances equal to the sum of emf and internal resistances of all the connected batteries. In this case we increase the voltage, but we also increase the internal resistance, so the maximum current which the new "battery" can provide does not change. If we connect the batteries in parallel, we do not increase the emf (it stays the same), but we reduce internal resistance of the new source.

Problems:

1. (less difficult) Find the current in the circuit below. The e.m.f. of the batteries are: E_1=3V, E_2=5V, the internal resistances are: r_1 =1Ohm, r_2 = 3Ohm.



2. (moderately difficult) Find all the currents in the circuit below. E. m. f. of the sources are: E_1=20V, E_2=50V, E_3=170V. Internal resistances of all the sources are equal to 10 Ohm. R_1=3 Ohm, R_2= 6 Ohm, R_3= 12 Ohm.



3. (more difficult) Current I in the circuit below is 1A, R=10 Ohm and internal resistances of the sources are 1 Ohm each. It was found that the magnitude of current I does not depend on resistance R1. Find e. m. f. of the sources (E_1 and E_2).