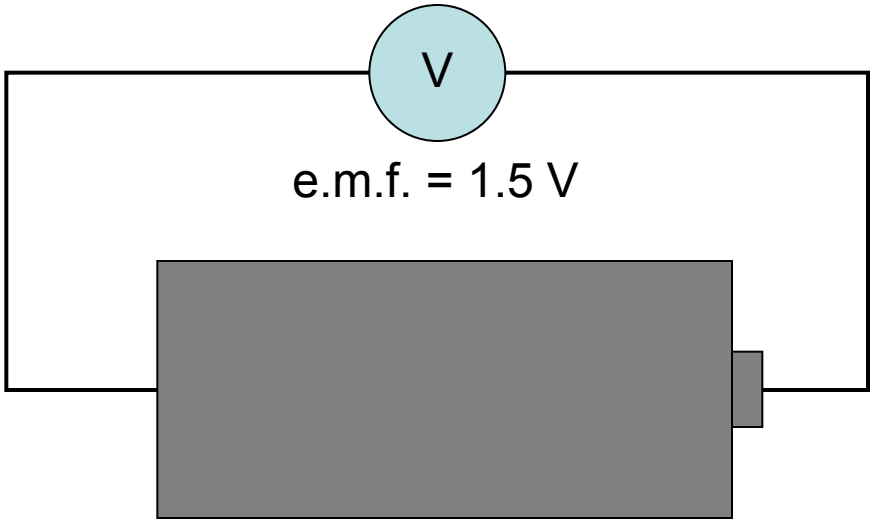
Internal Resistance

Batteries and Cells

Cells and batteries come in all shapes and sizes. They all have their ‘voltage’ marked on the side. This is called the e.m.f. (E) of the battery or cell.

e.m.f. stands for electromotive force.

If a voltmeter is connected to the terminals of a cell, it will measure the e.m.f.



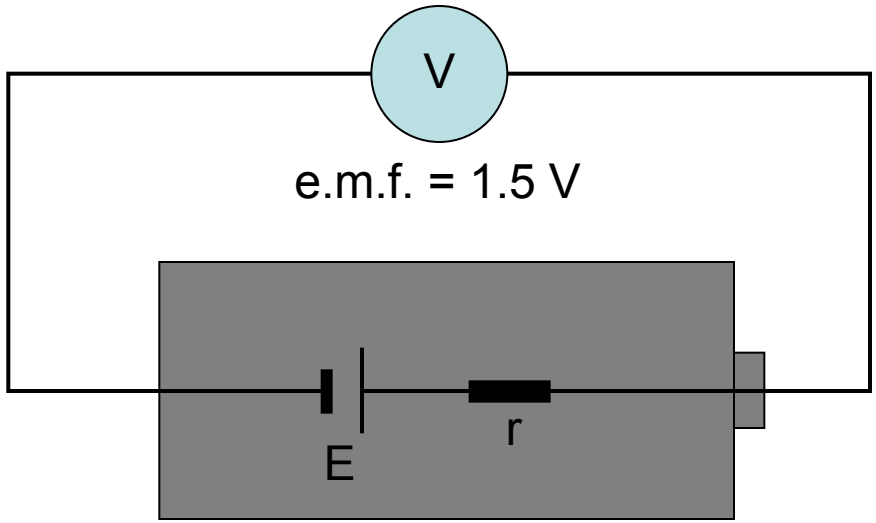
The e.m.f. tells you how many joules of energy the battery will supply to every coulomb of charge which passes through it.

1 volt is 1 joule per coulomb

Internal Resistance

Unfortunately, cells and batteries (and all other voltage supplies) also have INTERNAL RESISTANCE. It is a nuisance.

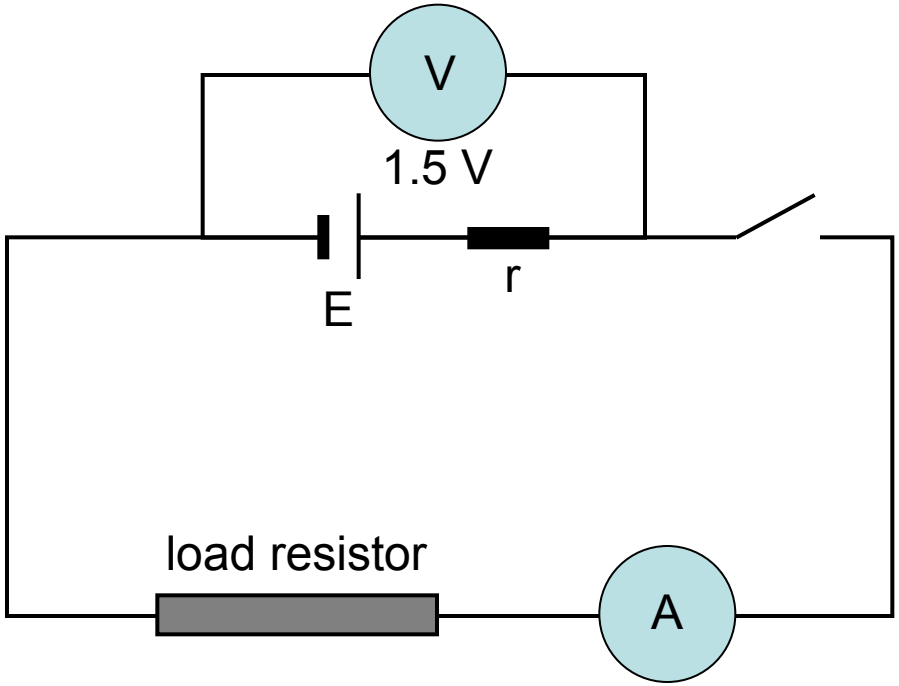
We use the symbol r to denote internal resistance and it is often drawn as a small resistor inside the voltage supply.



The problem with internal resistance is that it causes the voltage supplied by the supply to drop when you start to use it to supply anything with current.

Lost Volts

We call this drop in the voltage of the cell the LOST VOLTS. Remember that it only occurs when a current starts to flow.



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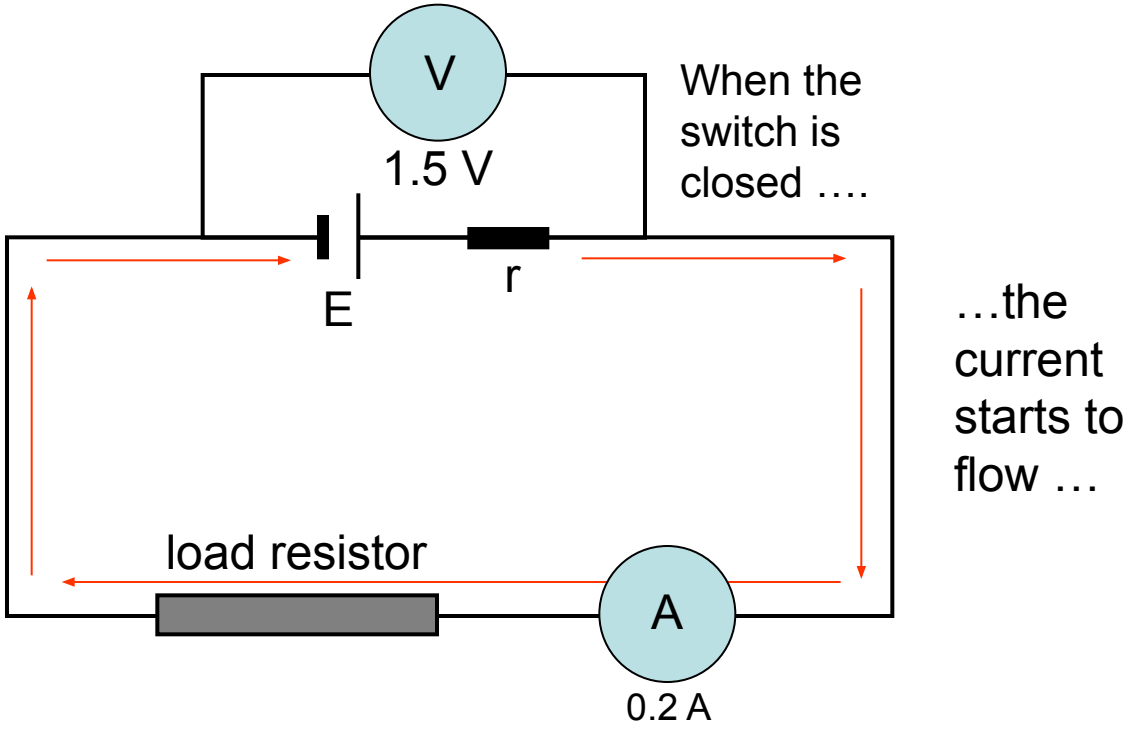

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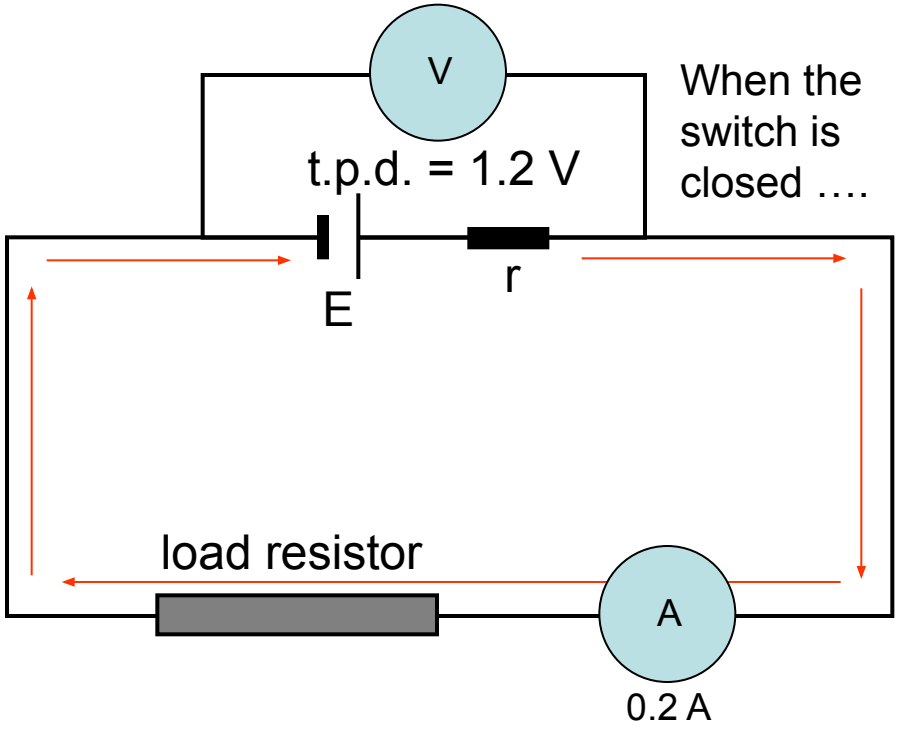
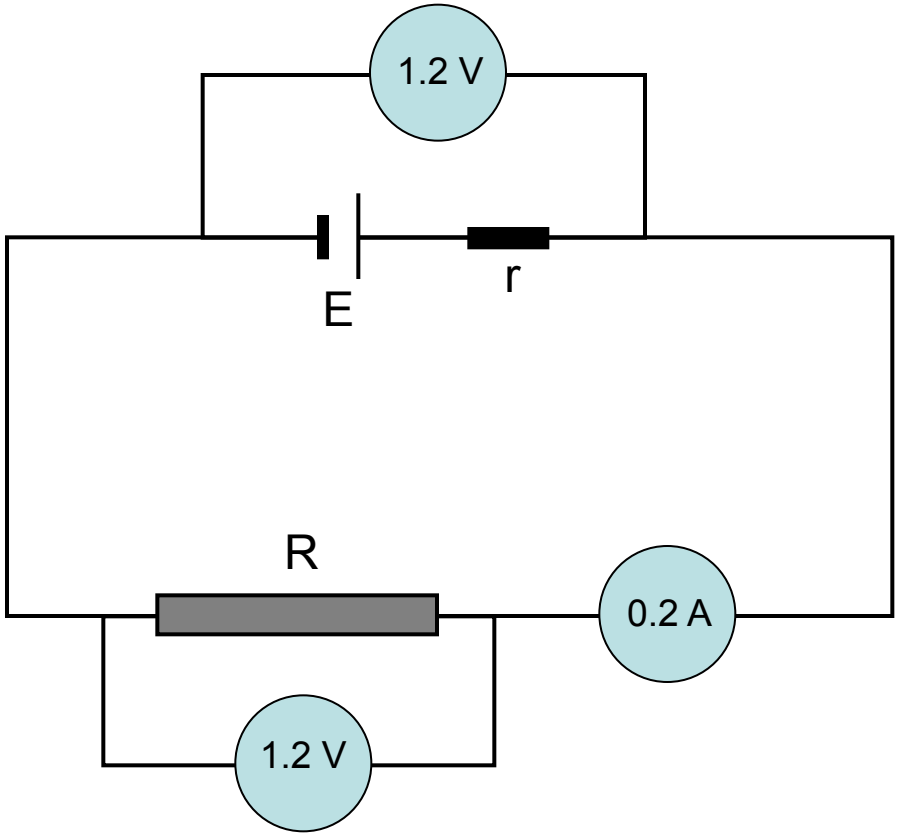


The voltmeter reading is no longer the e.m.f. It is now called the t.p.d. This stands for terminal potential difference. The lost volts = 0.3 V

The Terminal Potential Difference

This is not always the same. It depends on the size of the lost volts which, in turn, depends on the current in the circuit.



The voltage across the load resistor (R) will also be equal to the t.p.d.

The Equations

E = t.p.d. + lost volts

Ohm's law (V = I x R) can be applied in three ways.

For the whole circuit $E = I \times R_T$

For the Internal Resistance lost volts = I x r

For the Load Resistor t.p.d. = I x R

E.M.F

- E=IR+Ir
- It is defined as P . D. between the two terminals of the cell when the circuit is open i.e. R=infinity i.e. no current is drawn from the cell