Current Electricity

&

Ohm's Law

Circuit Basics

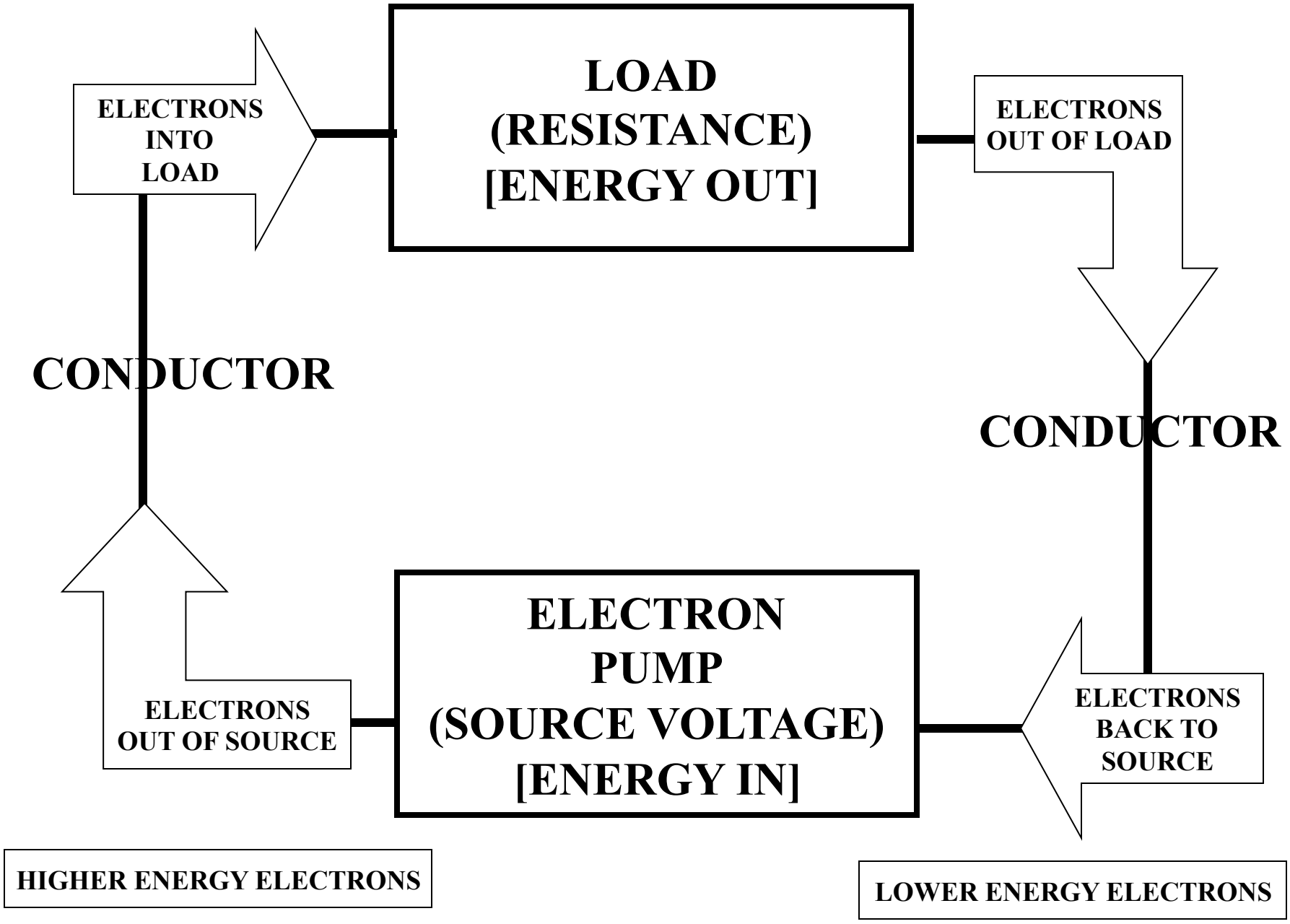
All electrical circuits require three elements.

(1) A source voltage, that is, an electron pump usually a battery or power supply.
[ENERGY IN]

(2) A conductor to carry electrons from and to the voltage source (pump). The conductor is often a wire.
[ENERGY TRANSFER]

(3) A load or resistance. A point where energy is extracted form the circuit in the form of heat, light, motion, etc.
[ENERGY OUT]

THE MOST BASIC ELECTRICAL CIRCUIT



Potential Changes of Current in a Circuit

High Energy current

Resistance (Potential Drop)

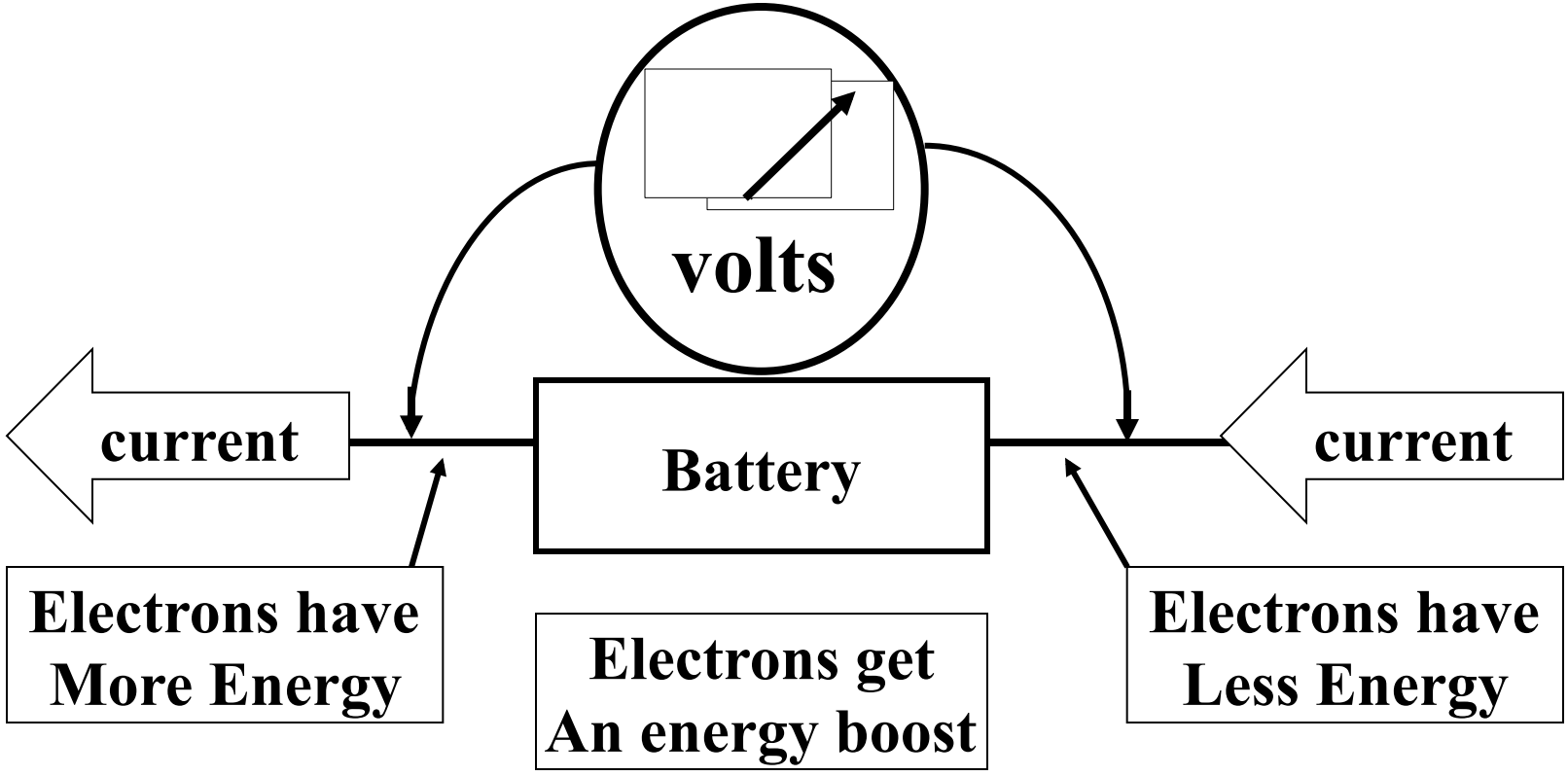
Low Energy current

High Energy current

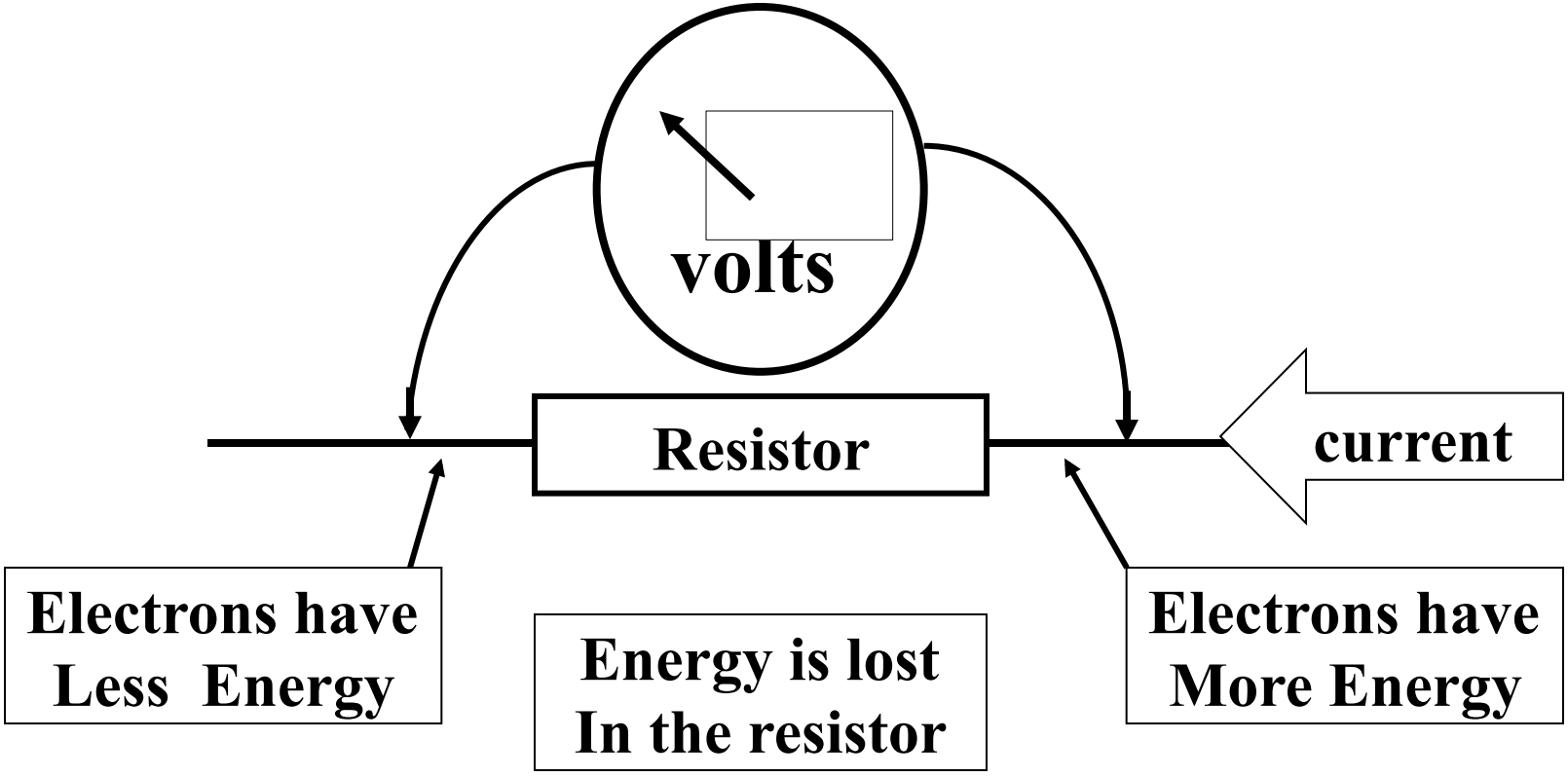
Voltage Source (Potential Rise)

Low Energy current

Potential Rise Across a Power Source



Potential Drop Across a Resistor



MEASUREABLE QUANTITIES THAT CAN BE OBTAINED FROM AN ELECTRICAL CIRCUIT

(1) VOLTAGE RISE – MEASURES THE ENERGY GIVEN TO ELECTRONS AS THEY LEAVE A VOLTAGE SOURCE. IT IS MEASURED IN VOLTS (+)

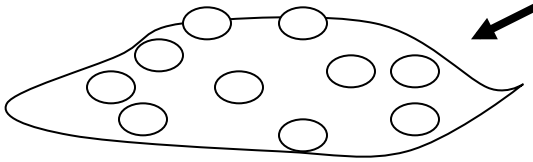
(2) VOLTAGE DROP – MEASURES THE ENERGY LOST BY TO ELECTRONS WHEN THEY LEAVE A RESISTANCE. IT IS MEASURED IN VOLTS (-)

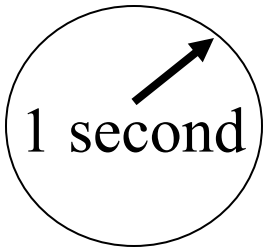
(3) CURRENT – MEASURES THE FLOW RATE THROUGH A CONDUCTOR. IT IS MEASURED IN AMPERES (AMPS)

(4)RESISTANCE – MEASURES THE OPPOSITION TO CURRENT FLOW THROUGH A CONDUCTOR OR RESISTOR
IT IS MEASURED IN OHMS (ITS SYMBOL IS OMEGA)

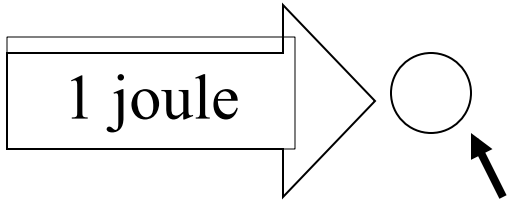
ELECTRICAL QUANTITIES

6.25 x 10^{18} electrons
1 coulomb





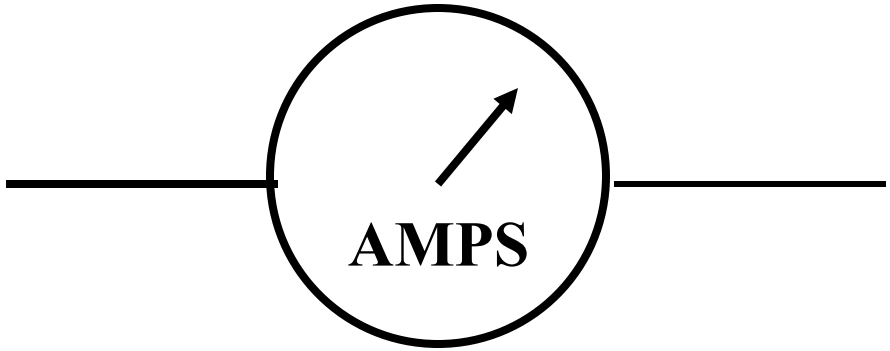
1 amp = 1 coul / sec



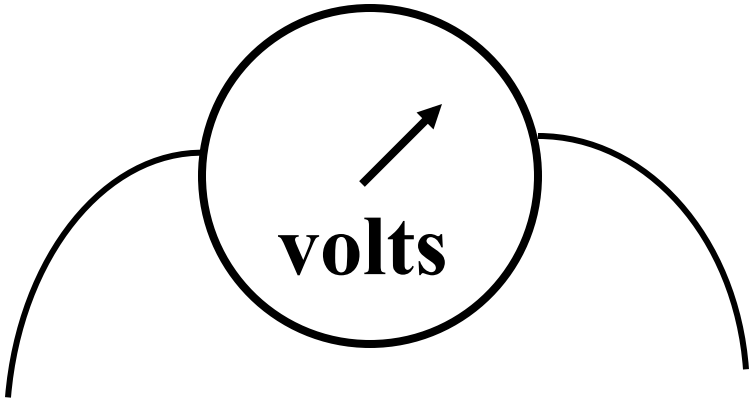
1 volt = 1 joule / coul

1 coulomb of charge

Electrical Meters



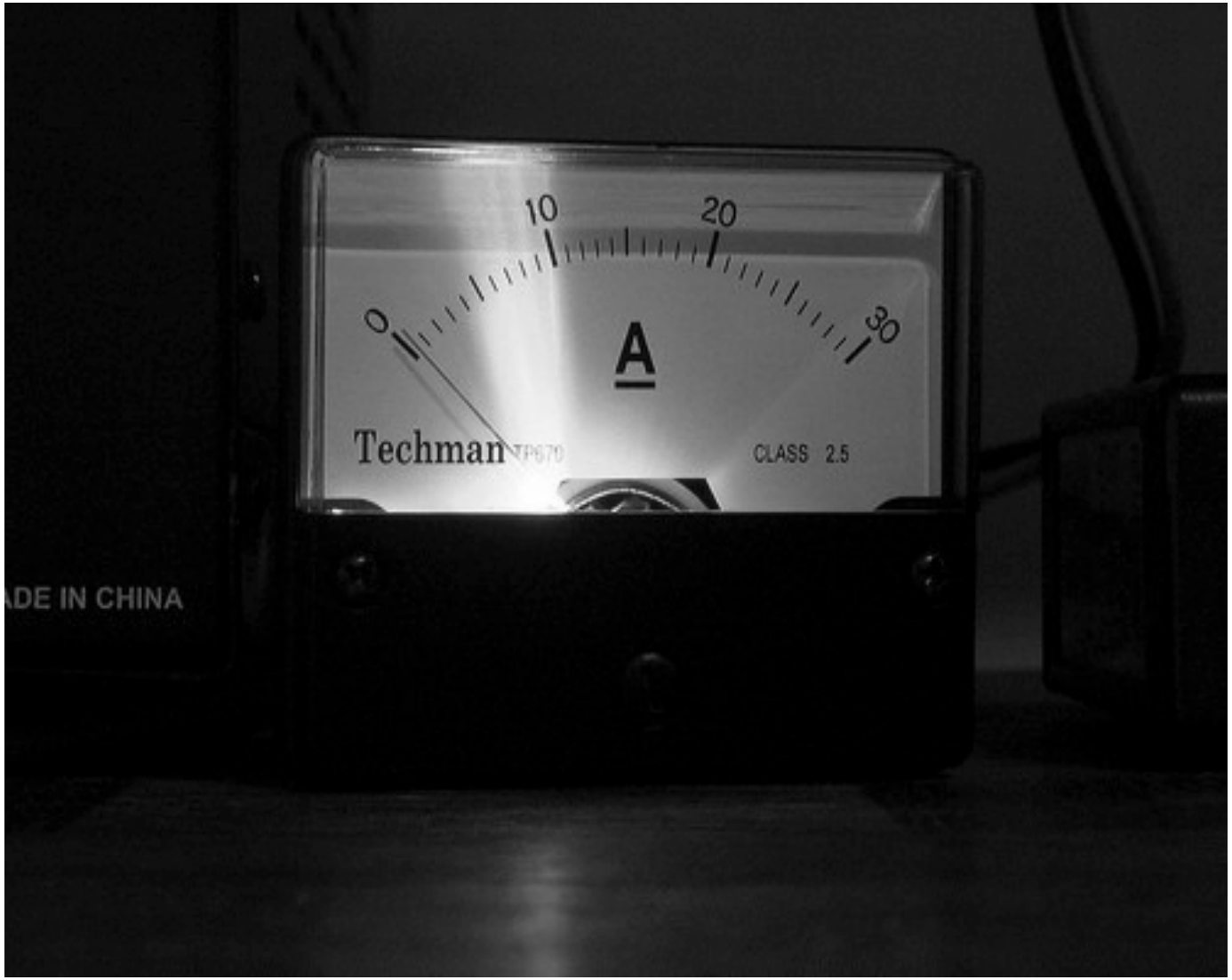
Ammeters measure current in amperes and are always wired in series in the circuit.



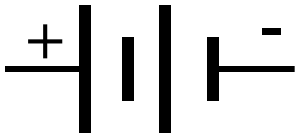
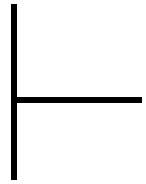
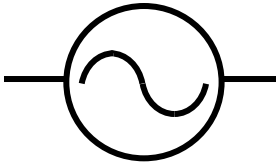
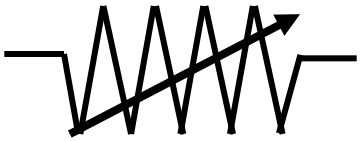
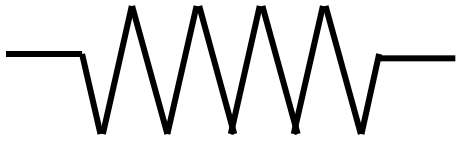
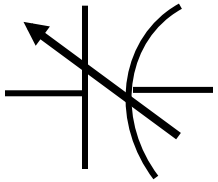
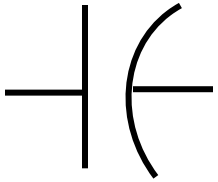
Voltmeters measure potential in volts and are always wired in parallel in the circuit.

An actual Voltmeter

An Actual Ammeter



Electrical Symbols

battery		junction	
wiring		terminal	
voltmeter		AC generator	
ammeter		Variable resistance	
resistance		Variable capacitor	
capacitor			

Relationships Among Electrical Quantities in a Circuit

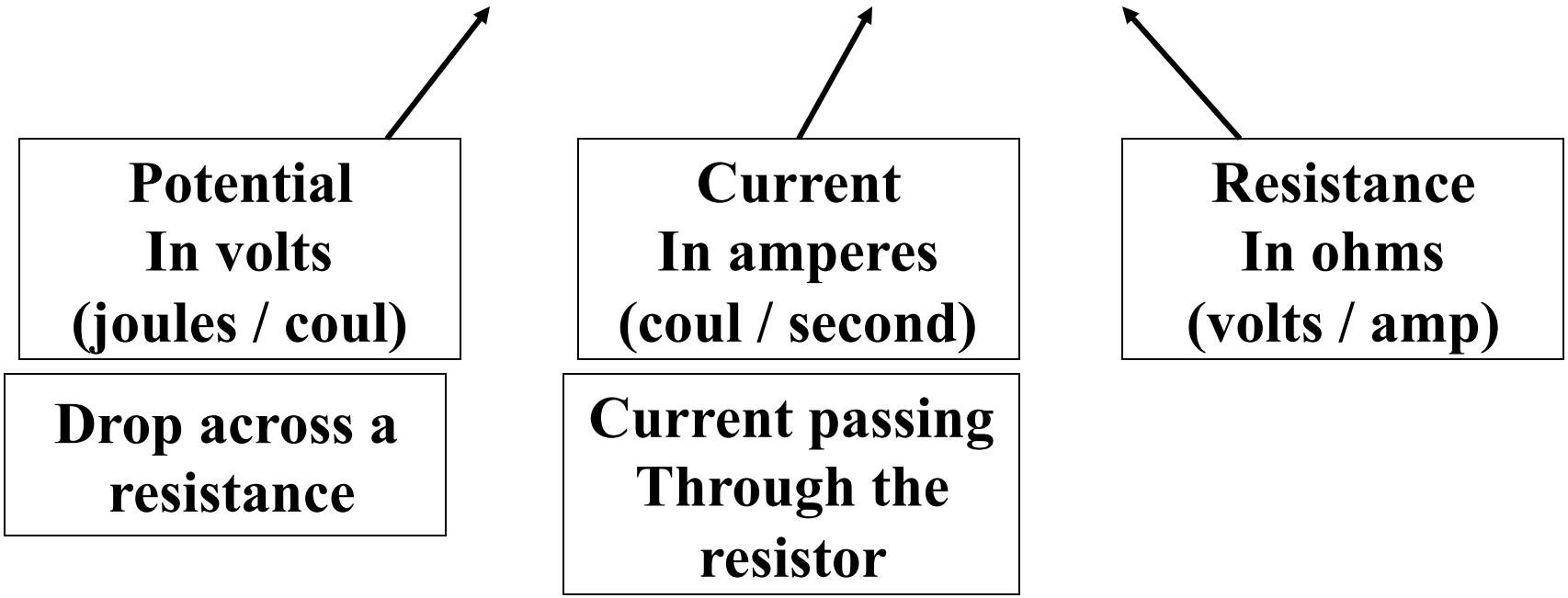
Measure electrical quantities in an electrical Circuit are related to eachother by:
OHM'S LAW

OHM'S LAW says, if the source voltage remains constant, increasing the resistance in a circuit will cause a decrease in current flow in that circuit.
In mathematical terms it tells us that current flow is inversely proportional to resistance.

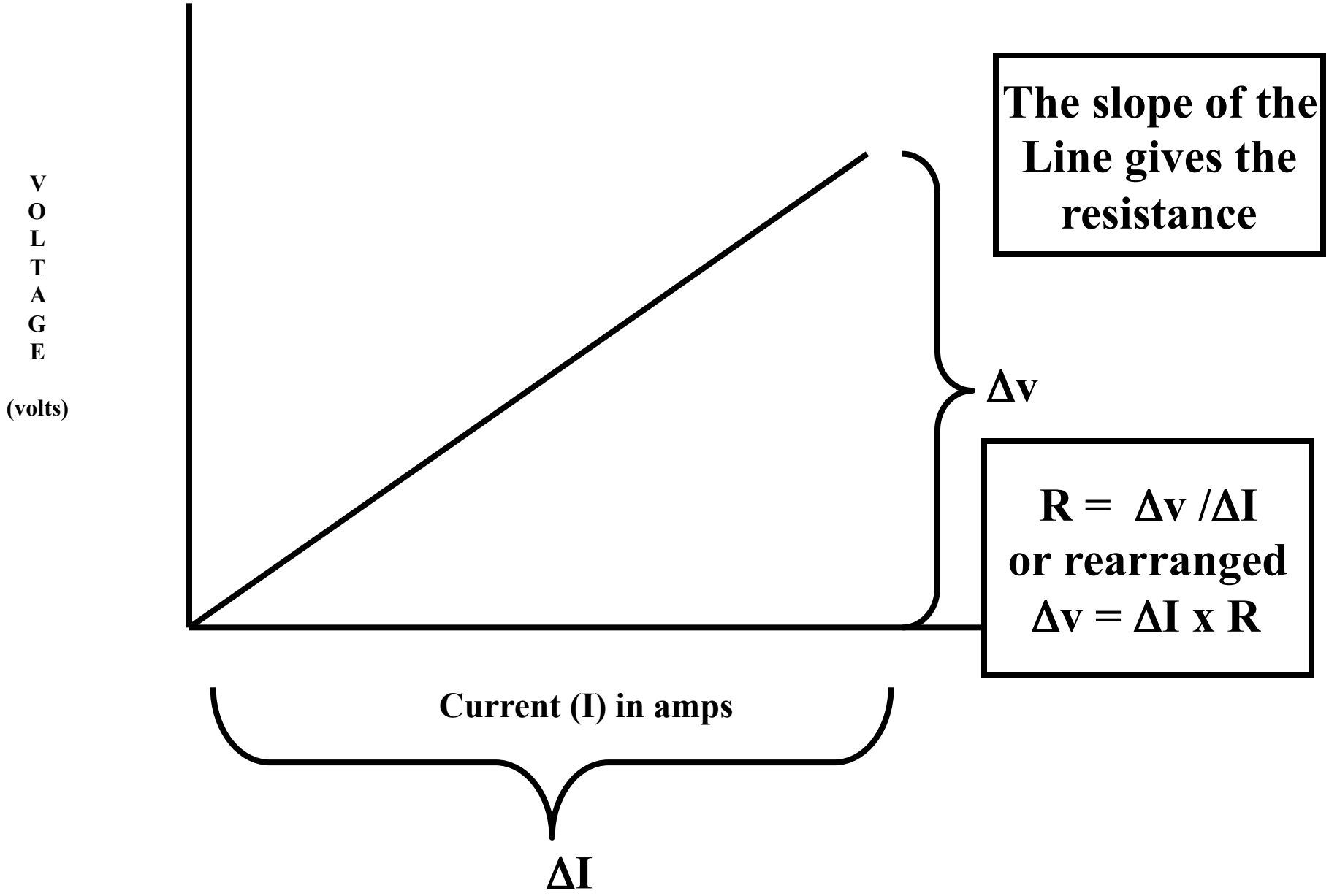
In equation form it says:
Voltage (V) = Current (I) x Resistance (R)
or
V(in volts) = I (in amps) x R (in ohms)

Ohm's Law

$$V = I R$$


Potential
In volts
(joules / coul)
Drop across a
resistance
Current
In amperes
(coul / second)
Current passing
Through the
resistor
Resistance
In ohms
(volts / amp)

Voltage vs Current for a Constant Resistance



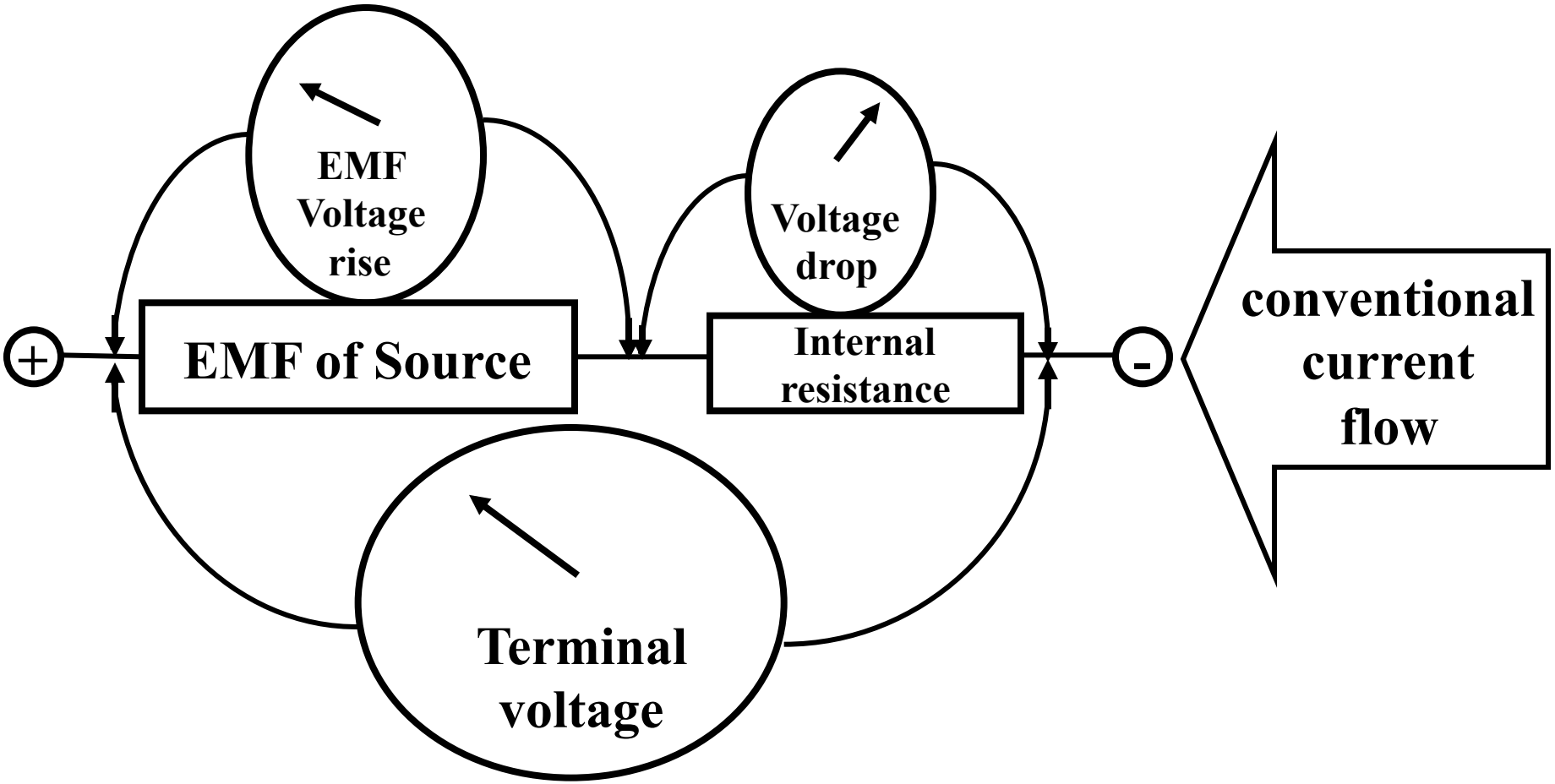
Voltage Sources and Internal Resistance

All voltage sources contain internal resistance, that is resistance that is part of the voltage producing device itself which cannot be eliminated.

The voltage that the device (battery for example) could produce if no internal resistance was present is called its EMF.
EMF stands for electromotive force – the force that moves the electrons.

The useable voltage which is available to the circuit after the internal resistance consumes its share of the EMF is called The terminal voltage.

Electromotive Force (EMF) and Terminal Voltage



terminal voltage = EMF (+) + Internal resistance loss (-)

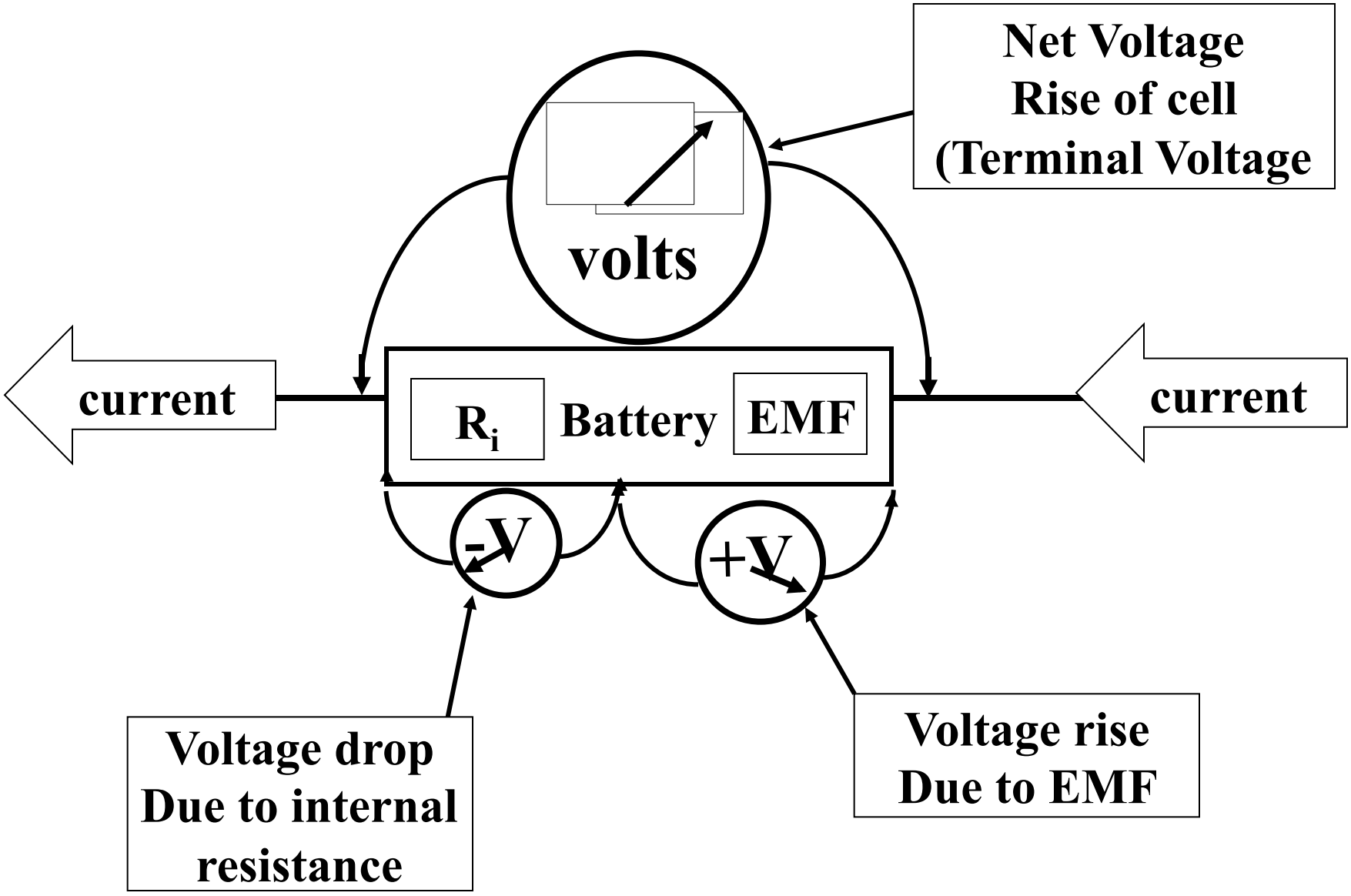
Since voltage rise across a source or
Voltage drop across a resistance can be
Calculated by Ohm's Law
V= IR
And the above equation becomes

$$V_{terminal} = EMF - I \times R_{internal}$$

Note that if $R_{internal}$ is very small then a large Percentage of the EMF is available to the circuit.

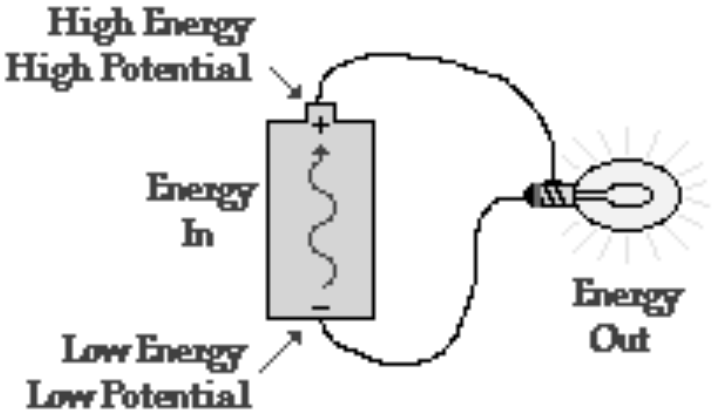
Also note that if I, the current is very large then a large percentage of the EMF is consumed within the battery itself which can cause overheating and failure. This is generally the result of a short circuit.

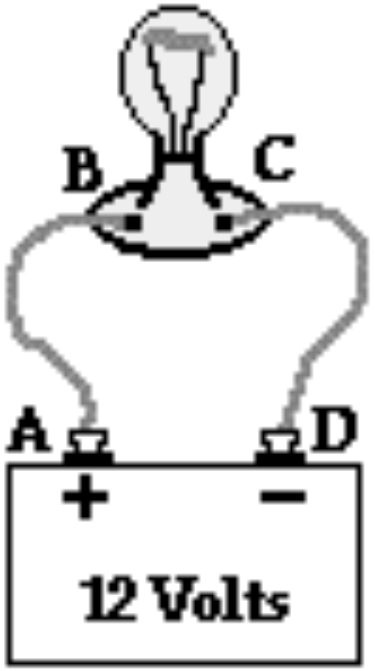
Internal Resistance and EMF



Electric Circuit

Electric Circuit – a closed loop of electron flow.

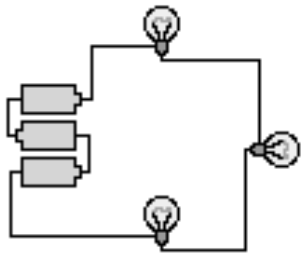




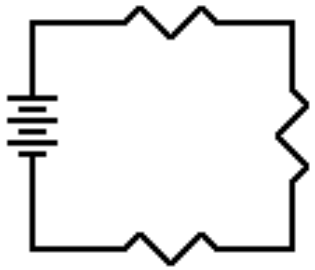
Circuit Symbols

Symbols

Drawing of Circuit

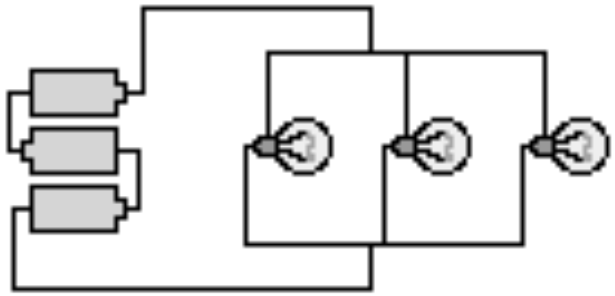


Schematic Diagram of Circuit



Circuits

Drawing of Circuit



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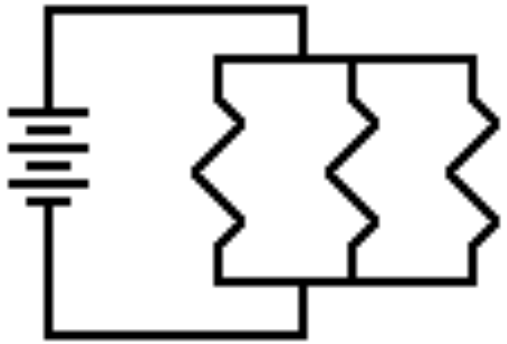


Types of Circuits

Series

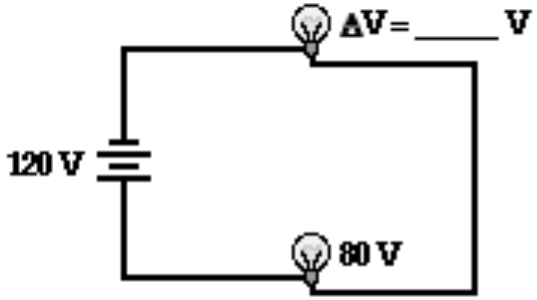


Diagram A

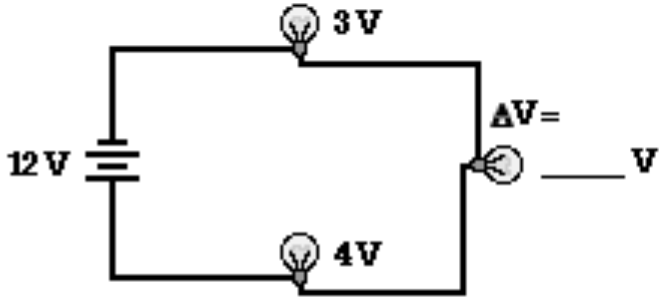


Diagram B

Parallel

Diagram A

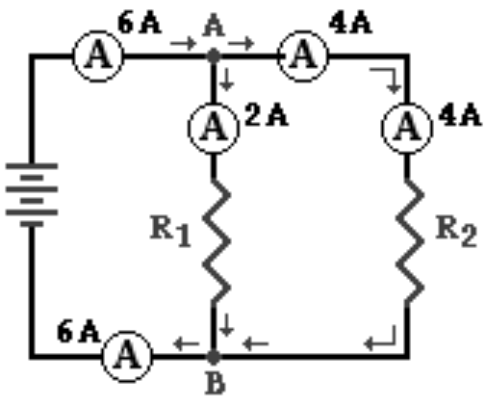
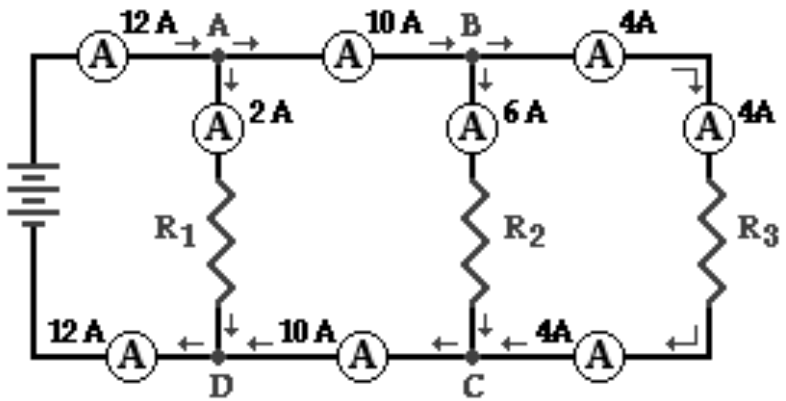


Diagram B



Types of Circuits

Combination