Electrical Current Flow

Electron Flow - From excess to deficient

Conventional Current Flow
- Internal to Source (Battery)
  - Negative to Positive
- External from Source (Battery)
  - Positive to Negative

Voltage Drop - Across a Resistor + to -

"*Negative Current*" - Assumed Direction Reversed

Electrical Theory

Ohm's Law
- $I = V/R$ (DC) $I = V/Z$ (AC)

Joule's Law
- $P = IE = I^2R$ (I Squared R Loss)

Kirchoff's Law
- Sum of Loop Voltages = 0
- Sum of Node Currents = 0

Electrical Theory

Quantity	Symbol	Unit	Equation
Charge	Q	coulomb	$Q = \int i dt$ $Q = CV$
Current	I	ampere	$I = dQ/dt$
Voltage	V	volt	$V = dW/dQ$
Energy	W	joule	$W = \int V dQ = \int P dt$
Power	P	watt	$P = dW/dt = IV$

Power and Voltage Ratios Expressed in Decibels (dB's)

1 Bel = $\log(Power_2 / Power_1)$

1 decibel = 1 dB = 0.1 Bel, hence 10 dB = 1 Bel

To express a Power Ratio in dB's, use dB = $10 \log(Power_2 / Power_1)$

Let $Power_2 = 2\ Power_1$
Power Ratio in dB's = $10 \log(2\ Power_1 / Power_1) = 10 \log(2) = 3.01$

Let $Power_2$ = 0.5 Power1
Power Ratio in dB's = $10 \log(0.5\ Power_1 / Power_1) = 10 \log(0.5) = -3.01$

-3 dB is often expressed as "3 dB Down" which is the half power point ($Power_2 = 1/2\ Power_1$)

Let $Power_2 = Power_1$
Power Ratio in dB's = $10 \log(Power_1 / Power_1) = 10 \log(1) = 0$

dB = 0 does not imply zero power but rather a power ratio of one-to-one
dB = 0 can be used as a zero reference; that is to say, set your reference level to a particular value and then use the dB scale to refer all other values to that reference level.

Examples: Reference Level = 400 watts.
200 watts = -3 dB
800 watts = +3 dB
400 watts = 0 dB
4000 watts = +10 dB
40 watts = -10 dB
650 watts = +2.1 dB
65 watts = -7.9 dB
100 watts = -6 dB
2,500,000 watts = +64 dB

Note: A reference of 1 milliwatts is used for dBm's
1 milliwatts = 10 log(1 / 1) = 0 dBm
5 milliwatts = 10 log(5 / 1) = +7 dBm
500 milliwatts = +27 dBm
0.001 milliwatts = -30 dBm

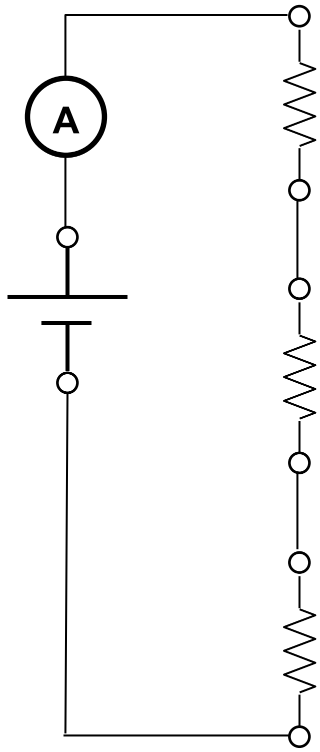
For Voltage, Power = $IE = (E/R)E = E^2/R$

To express a Voltage Ratio in dB's, use dB = $10 \log(Power_2 / Power_1) = 10 \log[(E_2^2/R) / E_1^2/R)]$
$10 \log[(E_2^2/R) / E_1^2/R)] = 10 \log(E_2^2 / E_1^2) = 20 \log(E_2 / E_1)$

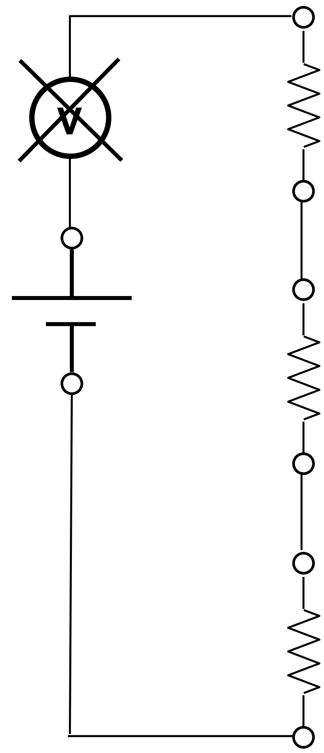
Let Power Ratio dB = -3, then $20 \log(E_2 / E_1) = -3$
$\log (E_2 / E_1) = -0.15$
$E_2 / E_1 = 0.707 = 0.5\ \mathrm{SQRT}(2)$

DMM Connections

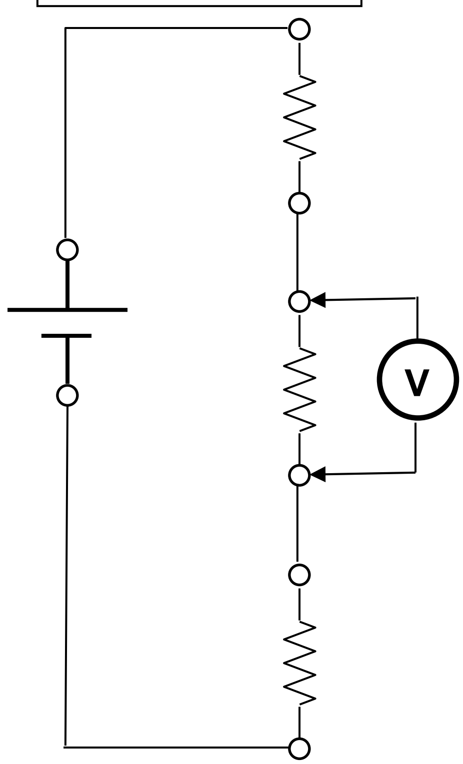
Ammeter in Series
OKAY



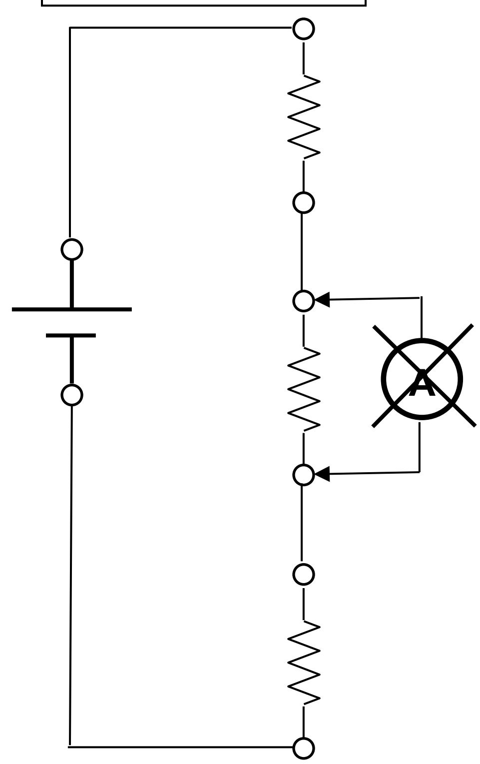
Voltmeter in Series
Prohibited



Voltmeter in Parallel
OKAY



Ammeter in Parallel
Prohibited



Change to Units (Amps, Volts, Watts)

From	To Units	
Milli	÷ 1000	10^{-3}
Micro	÷ 1,000,000	10^{-6}
Kilo	x 1000	10^{3}
Mega	x 1,000,000	10^{6}

Change from Units to Multiples

To		
Milli	x 1000	10^{3}
Micro	x 1,000,000	10^{6}
Kilo	÷ 1000	10^{-3}
Mega	÷ 1,000,000	10^{-6}