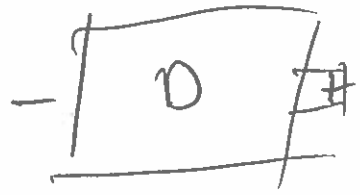
Voltage like gravitational potential energy does not have absolute zero pt.

$V_b = 1.5\,V$



$$U = QV$$

Ground $\Rightarrow$ Earth is large repository of free charge. charges can be drawn as needed best Ground Drive a metal rod ~ 3 feet

common Ground is a point in a circuit Agreed to be zero volts

$\perp$

$$U_e = k\frac{Q_1 Q_2}{r_{12}}$$

Voltage is electrical potential energy per unit charge

$$1\ \text{Volt} = 1\ \text{J/C}$$

which is more dangerous voltage or current?

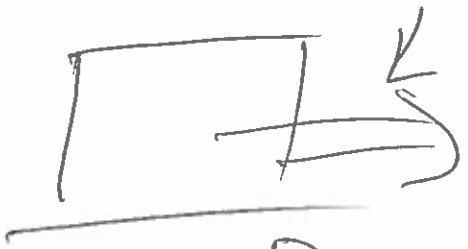
Voltage is $\frac{\text{Energy}}{\text{Charge}}$ current $\frac{\text{Charge}}{\text{time}}$

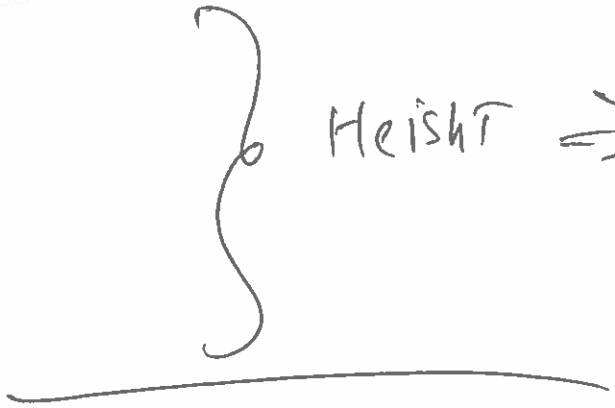
$$Vi = \left(\frac{\text{Energy}}{\text{Charge}}\right)\left(\frac{\text{charge}}{\text{time}}\right) = \frac{\text{Energy}}{\text{time}}$$

$$= \underline{\text{Power}}$$

Water Analogy

Water flow ⇒ Current

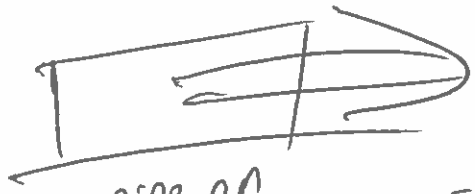




Height ⇒ Voltage

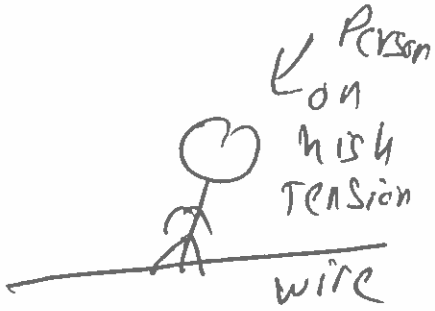
Consider 3 Cases

1)



High current
Low Voltage

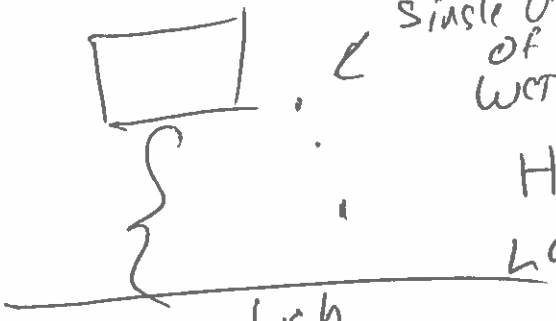
Water pipe on Ground Gushing water



Person on high tension wire

Both have Low power

2)

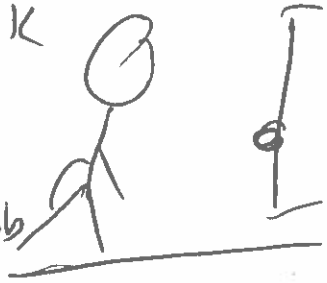


single drops of water

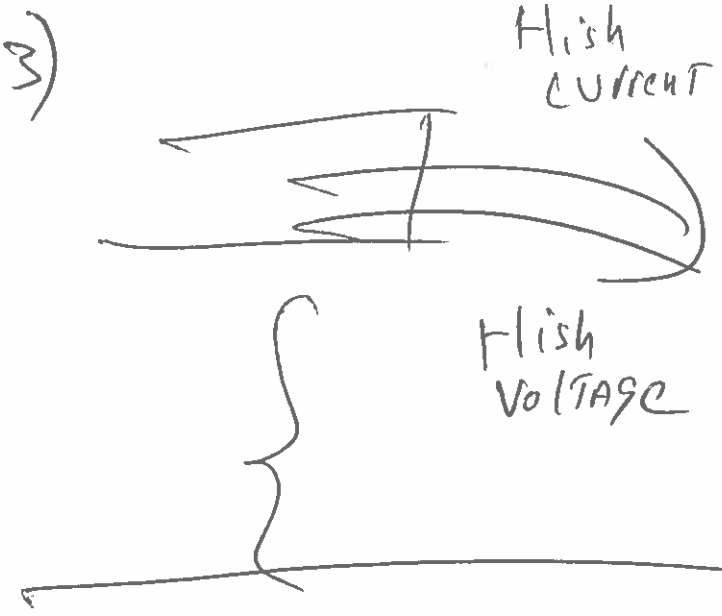
High Voltage
Low current

Water pipe high Above Ground

walk across carpet touch door knob



3)



3rd rail of subway

Death!

High Power

$$\left(\frac{J}{C}\right)\left(\frac{C}{S}\right) \Rightarrow J/S \Rightarrow \text{WATT}!$$

$$P = iV$$

$$P = \frac{dq}{dt}\frac{dU}{dq} \Rightarrow \frac{dU}{dt}$$

$$Q = 6C$$

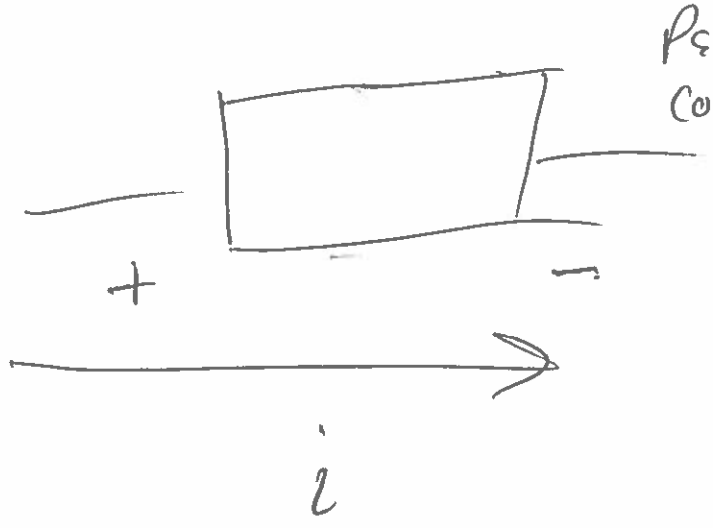
$$i = \frac{dQ}{dt} = 0$$

$$Q = 6t^2 - 3t + 7$$

$$i = 12t - 3$$

$$Q = \int i \, dt$$

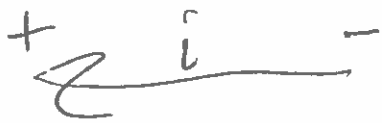
Passive Power Convention



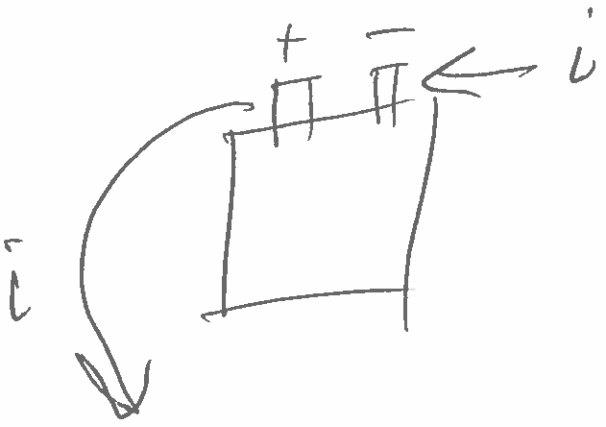
Voltage drop

Power delivered or dissipated

$P < 0$ Sign convention



– ACTIVE COMPONENT



Voltage rise

Power supplied

$P > 0$

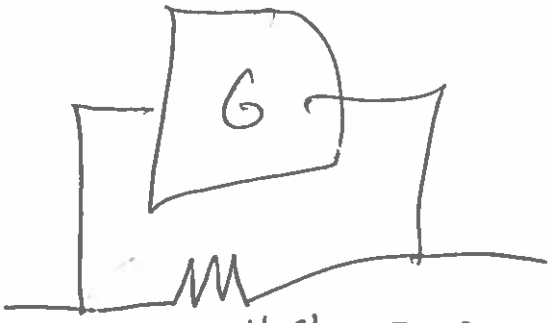
Ammeters Measure Current always wired in series

Voltmeters measure voltage always wired in parallel.

Both have Galvanometers as part of them.

Galvanometers measure current

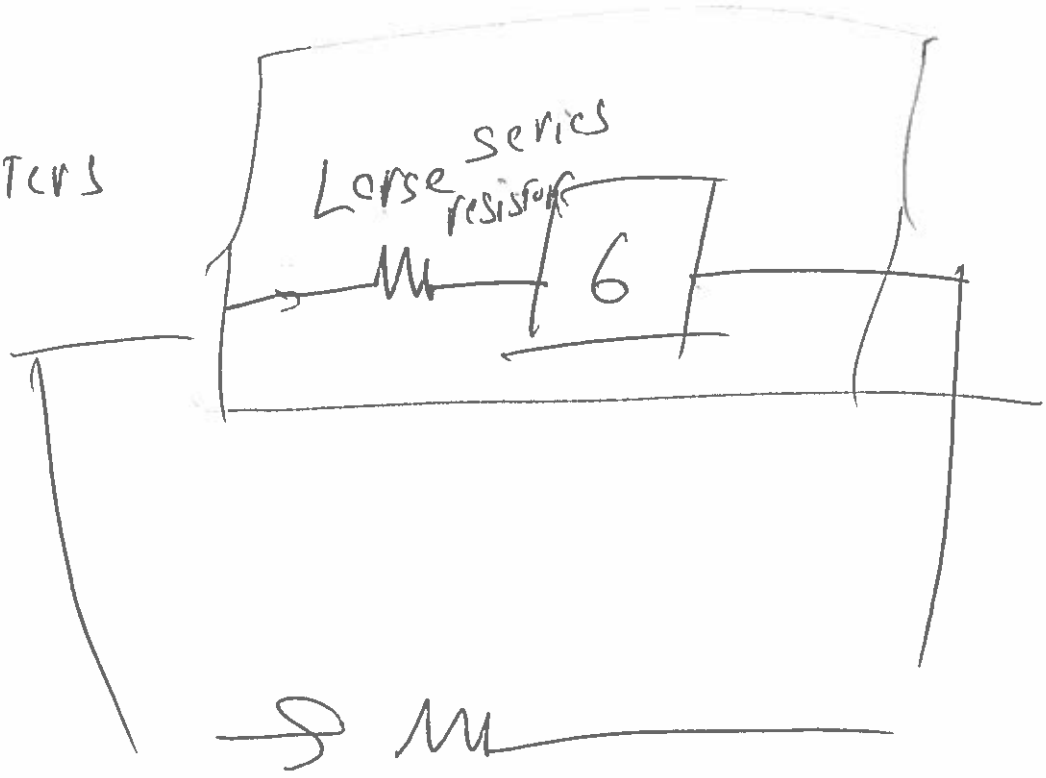
Ammeters



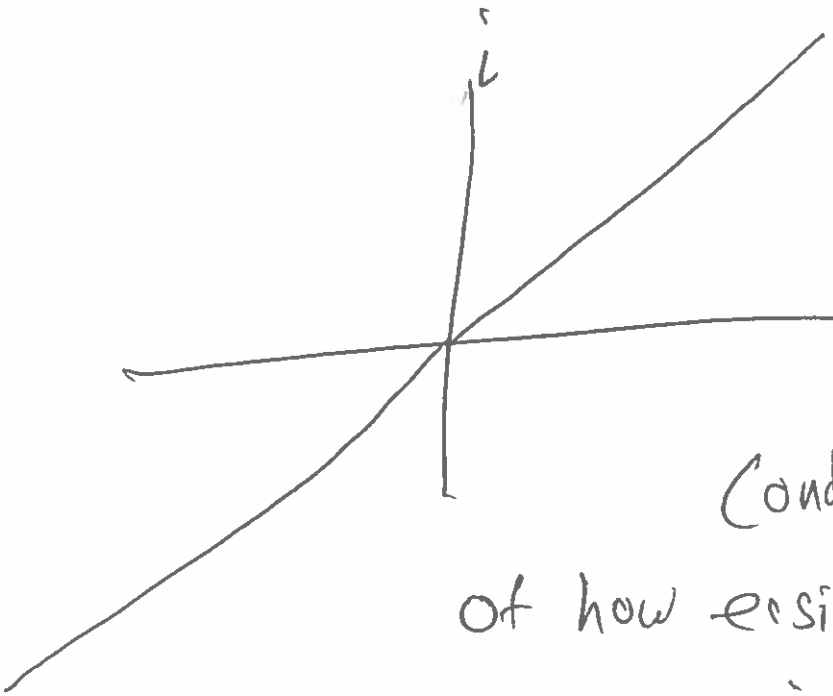
small shunt resister

So most current avoids Galvanometer

Voltmeters



Ohm's Law



Conductance

$$i = GV$$

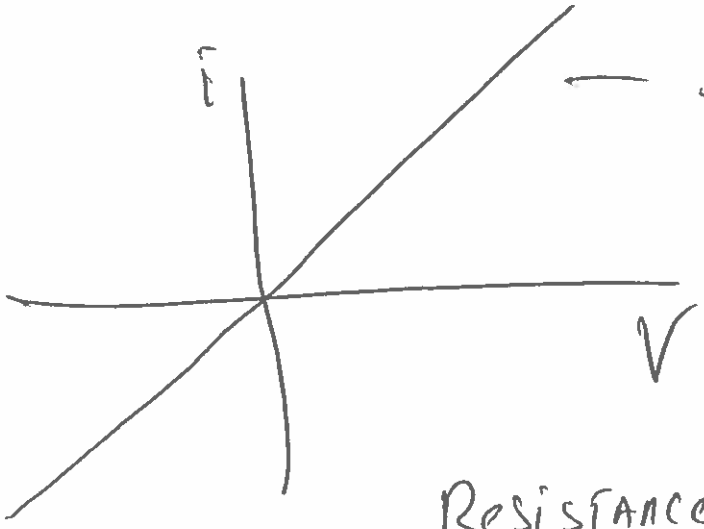
$$J = \sigma E$$

current density i/A

V/d

Conductance is a measure of how easily current flows when a voltage is applied.

Resistance $R = \frac{1}{G}$



— Slope $= \frac{1}{R}$

$$i = \left(\frac{1}{R}\right) V$$

Resistance is the opposition to the flow of current (charge)