To finish up background on Electric Currents:

Ammeter

- an ammeter measures the current in amps at a point in the circuit.

- measures the number of coulombs of charge passing through it every second

- it is placed in <u>series</u> in the circuit at point where the current is to be measured

Voltmeter

- measures the energy in joules which is converted into other energy forms by each coulomb of charge as it passes between two points. An energy difference per unit charge is called the <u>potential difference</u>

- think of the voltmeter as an "energy sensor". It measures the difference in electrical potential energy between two points of each coulomb of charge as it moves between those points.

- it is calibrated in volts $\underline{1}V = 1\,J\,C^{-1}$

- it is placed in parallel in the circuit
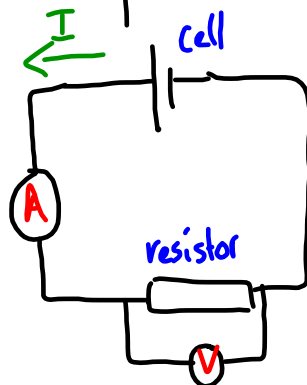
Electric potential differce (V)

symbol

$$V = \frac{\Delta E_p}{q}$$

A   B

$\leftarrow V \rightarrow$
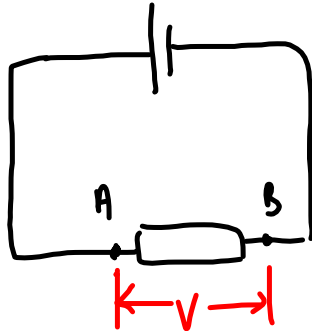
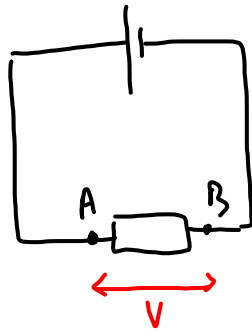units: $1V = 1\ J\ C^{-1}$

the unit for volt

scalar quantity.

Test Charge

— hypothetical charge used to define certain quantities

Potential Difference should be used rather than voltage
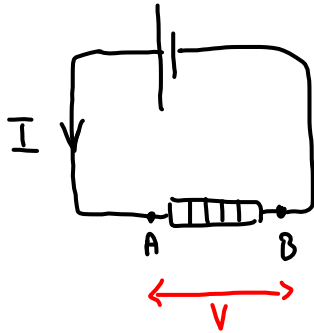
Consider a positive test charge moving from A to B:

work is done to move the charge (test) from A to B. Recall work is equal to the change in energy.

$$V = \frac{\Delta E_p}{q} \quad \leftarrow \text{change in potential energy}$$

$$V = \frac{\Delta W}{q} \quad \leftarrow \text{work}$$

Change in Potential Energy

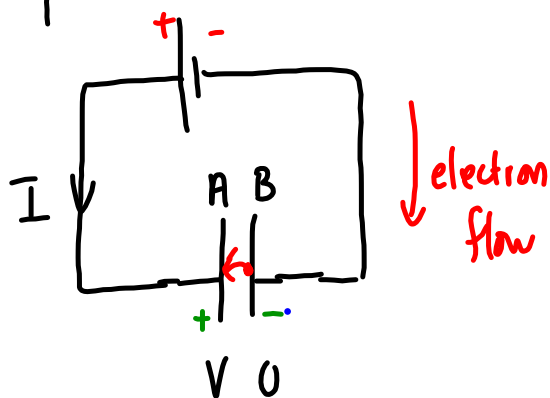$$V = \frac{\Delta E_p}{q} \quad \text{(definition)}$$

$$\Delta E_p = qV$$

$$\Delta E_p = VI\Delta t$$

recall: $I = \frac{\Delta q}{\Delta t}$

$$\Delta q = I\Delta t$$

▷ the loss in potential energy ⟹ heating the resistor (thermal energy)

∗ This is the internal energy which is generated in the heating element (resistor) in time Δt

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Suppose that instead of a resistor, that we have two parallel plates separated in a vacuum:

Suppose an electron of charge e released from rest and it moves toward A.

at B, the electron has potential energy
$$E_p = eV \quad , \quad E_k = 0$$

at A, the electron has no potential energy but has kinetic energy
$$E_p = 0 \quad , \quad E_k = \frac{1}{2}mv^2$$

The total energy of the electron is the same at A and B.

$$\therefore \quad eV = \frac{1}{2}mv^2$$

Where e is the elementary charge

V is the potential difference.

m is the mass of the electron

v is the speed of the electron as it strikes plate A

<u>Example</u> I Δt

A current (5.0A) flows for (30 s) through an electric heating V
element which has a potential difference across it of (8.0V)

a) How much charge flows through the element in 30s?

$\underset{\Delta q}{\underline{\hspace{3cm}}}$

$I = 5.0\,A$ $I = \dfrac{\Delta q}{\Delta t}$ units

$\Delta t = 30s$

$\Delta q = ?$ $\Delta q = I\,\Delta t$ $(Cs^{-1})(s) = C$

$\Delta q = (5.0\,(A))(30s)$

$\Delta q = 150\,C$

b) What is the loss in electrical potential energy of
this charge in 30s?

$V = \dfrac{\Delta E_p}{q}$ (definition)

$\Delta E_p = q\,V$ $(C)(JC^{-1}) = J$

$\Delta E_p = (150\,C)(8.0\,(V))$

$\boxed{\Delta E_p = 1200\,J}$

loss of potential energy

c) How much internal energy is generated in the heating
element?

gain in internal energy → 1200J of internal
energy

d) How much power is generated in the heating element?

$P = \dfrac{\Delta E_p}{\Delta t}$

$P = \dfrac{1200\,J}{30\,s}$

$P = 40\,W$