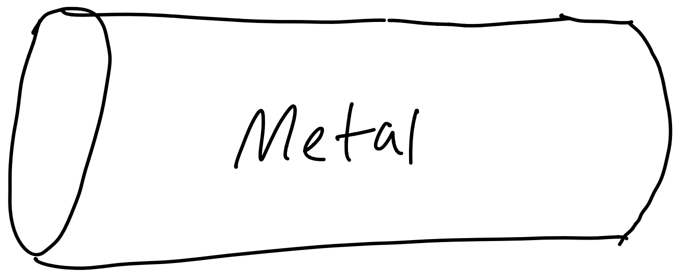
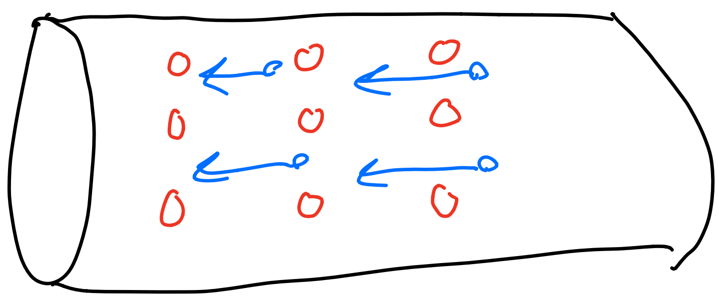
Outline

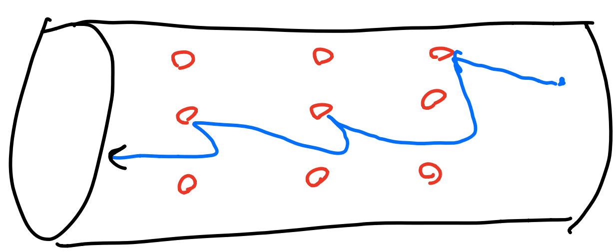
- Review of charge motion in conductors
  - Electron velocity and electron current
- Equilibrium vs steady state
- Conservation of current: the node rule
- Thick and thin wires
  - Currents, velocities, fields

$\vec{E} \longrightarrow$



What happens?





$$\bar{v} = uE$$

$\bar{v} = uE$

Drift Velocity

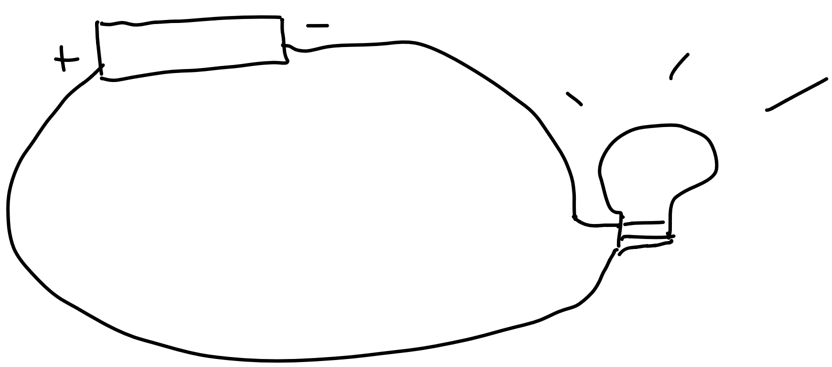
e - Mobility

$i = \#e/sec$

$i = nA\bar{v}$

$I = |q|i$

A simple circuit



- What happens to the bulb?
- Are we in equilibrium?
- Not static Eq, but "steady state"

Charge Motion in Conductors

Static Eq	Steady State
$\bar{v} = 0$	$\bar{v} \neq 0$ (Not changing)
$i = 0$	$i \neq 0$
$E_{net} = 0$	$E_{net} \neq 0$

$\left.\begin{matrix} i \neq 0 \\ E_{net} \neq 0 \end{matrix}\right\}$ not changing

CQ

18.2.a

- e^- move away from neg terminal

CQ 18.2.c

is the current used up in the bulb?

- Charge is conserved. Electrons cannot be destroyed.
- Charge does not pile up, current would eventually stop

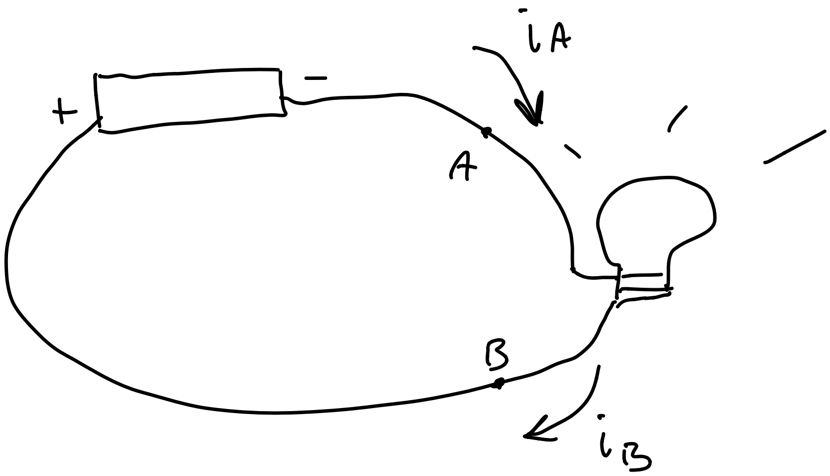
current is same

NODE RULE:

$$i_{IN} = i_{OUT}$$

(conservation of charge + steady state)

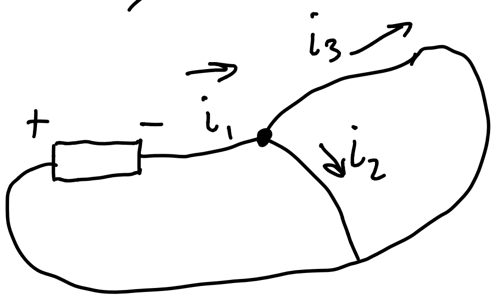
A "node" is just a point on the circuit



$i_{IN} = i_A$

$i_{OUT} = i_B$

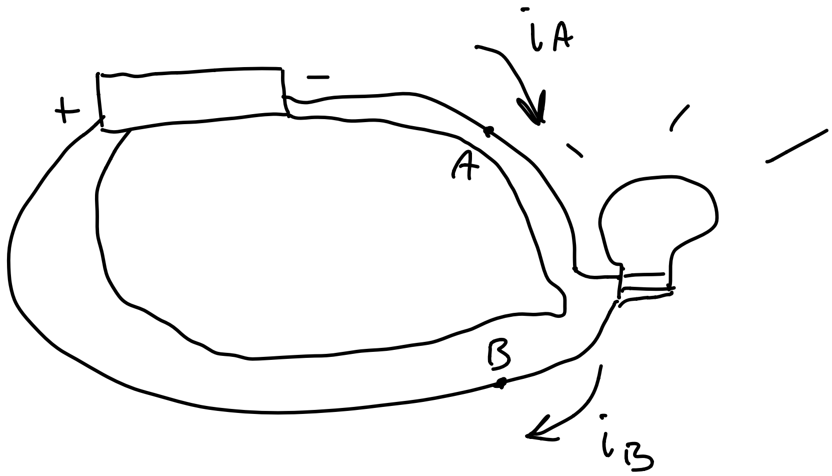
$i_A = i_B$



$i_{IN} = i_1$

$i_{OUT} = i_2 + i_3$

$i_1 = i_2 + i_3$

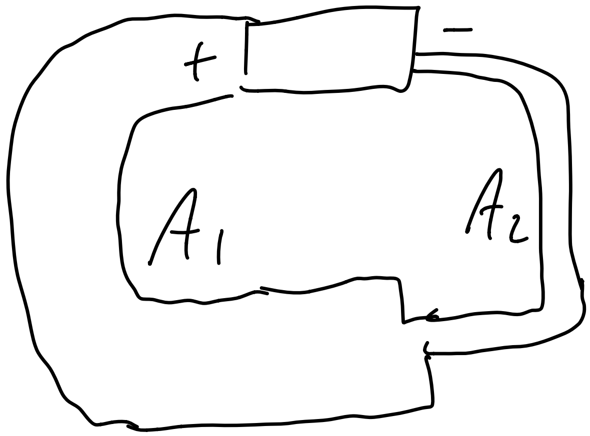


$i_A = i_B \qquad i = nA\bar{v}$

$\cancel{n_A}\cancel{A_A}\bar{v}_A = \cancel{n_B}\cancel{A_B}\bar{v}_B$

$\bar{v}_A = \bar{v}_B$

CQ 18.2.d



$$i_2 = i_1$$

V_1, V_2 ?

$$V_2 > V_1$$

$$n A_1 \bar{v}_1 = n A_2 \bar{v}_2$$

$$\bar{v}_1 = \frac{A_2}{A_1} \bar{v}_2 \ , \quad \frac{A_2}{A_1} < 1$$

$$V_1 < V_2$$

(water in a pipe)

$$A_1 = 4A_2$$

$$\bar{V}_1 = \frac{1}{4}\bar{V}_2$$

$\vec{E}$?

$$n_1 A_1 \bar{V}_1 = n_2 A_2 \bar{V}_2$$

$$\bar{V} = uE$$

$$n_1 A_1 u_1 E_1 = n_2 A_2 u_2 E_2$$

Same material

$$n_1 = n_2$$

$$u_1 = u_2$$

$$A_1 E_1 = A_2 E_2 \Rightarrow E_1 = \frac{A_2}{A_1} E_2$$

$$E_1 = \frac{1}{4} E_2$$

CQ 18.3e

$$i_1 = i_2$$

$$n_1 A_1 u_1 E_1 = n_2 A_2 u_2 E_2$$

$$A_1 = A_2$$

$$n_1 u_1 E_1 = n_2 u_2 E_2$$

$$E_1 = \frac{n_2 u_2}{n_1 u_1} E_2 \quad , \quad \frac{n_2}{n_1} = 3$$

$$E_1 = \frac{3 u_2}{u_1} E_2$$