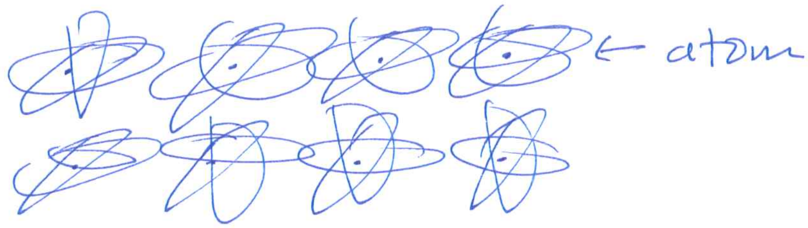
Solid:



Free electrons (1 per atom) can move.

Current

$$I = \frac{dq}{dt}$$

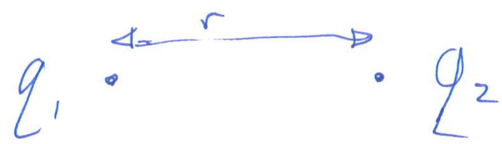
Charge per time crossing a plane

book notation

q charge

e charge on one electron

$= -1.6 \times 10^{-19}\ C$



$$F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2} = q_1 \vec{E}(\vec{r})$$

Charge q_2 "creates" electric field.

A system of n charges creates

$$\vec{E}(\vec{r}) = \frac{1}{4\pi\varepsilon_0} \sum_i \frac{q_i}{r_i^2} \hat{r}$$

In general $\vec{E}(\vec{r})$ can be complicated...

For now, assume $\vec{E}(\vec{r})$ known.

~~Don't worry about~~

"What is voltage"

$$V_a - V_b \equiv V_{ab} \equiv \Delta V = -\int_b^a \vec{E} \cdot d\vec{s} = -\int_a^b E\,dx$$

ΔV called "potential difference"

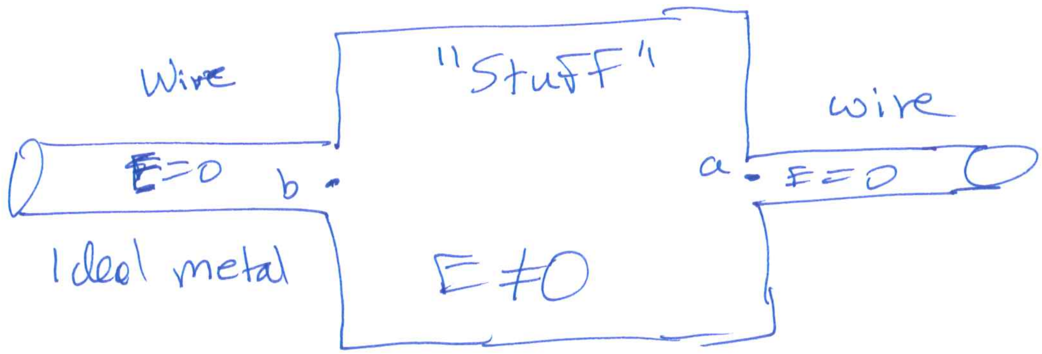
Inside an <u>ideal</u> metal $E = 0$.

⇒ The potential difference between any 2 points inside a metal is <u>zero</u>.

So what is Voltage?
Segway P. 764

"A variety of phrases are used to describe the potential difference between two points, the most common being <u>voltage</u>, arising from the unit for potential. A voltage "applied" to a device, such as a television, or "accross" a device is the same as the potential difference accross the device. If we say that the voltage applied to a light bulb is 120 volts, we mean that the potential difference between the two electrical contacts on the light bulb is 120 volts."

My interpretation:



$$\Delta V = -\int_b^a E\,dx \neq 0$$

So inside "stuff" there must be regions where $E \neq 0$.

In this class, we usually don't care about the details of E.

We mainly care about the relationship between I, V:

"Components"

Physical objects with ideal metal wires attached. Inside the objects $E \neq 0$. (somewhere)

Resistor

$V = IR$

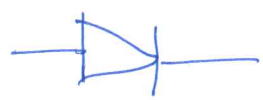
Capacitor

$Q = CV \qquad I = \frac{dq}{dt} = C\frac{dV}{dt}$

Inductor

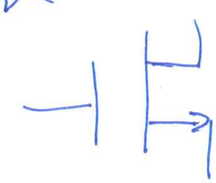
$V = L\frac{dI}{dt}$

Diode



$I = I_0\left(e^{qV/kT} - 1\right)$

Transistor (3 terminal)

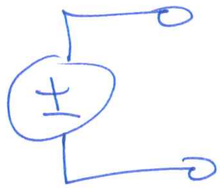


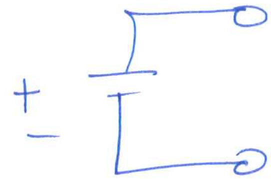
FET

BJT

An ideal voltage source <u>Forces</u> ΔV to be a constant value.

<u>Voltage source</u>

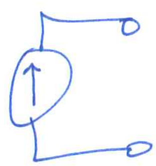
v 

v 

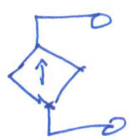
ac or dc   dc

(Battery is an almost ideal voltage source.")

<u>Current source</u>

i 

independent current source

i 

Dependent current source

i depends on what is going on somewhere else in circuit.

ac = alternating current   i depends on time

dc = direct current   i independent of time

Use of "ac" "dc" has evolved.

ac current = time dependent current

dc current = time independent current

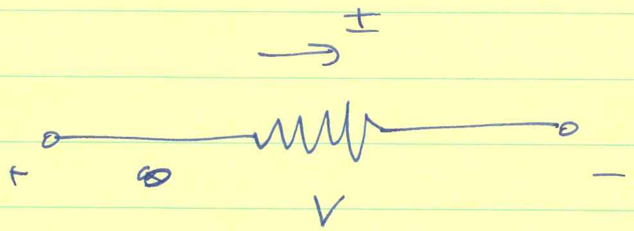
ac voltage = time dependent voltage

dc voltage = time independent voltage

(7) [illegible]

[illegible]

Power



$P = Vi$ [Watts] = [V · A]

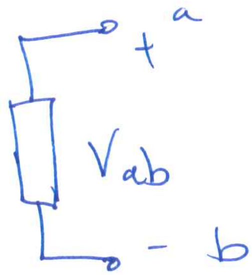
Example light bulb 100 W

Oven 1 kW

wristwatch 1 mW

Fig.

Book 1.6



$$V_{ab} = -\int_b^a E \cdot dx$$

= ~~E b~~

$\equiv$ $\triangleq$

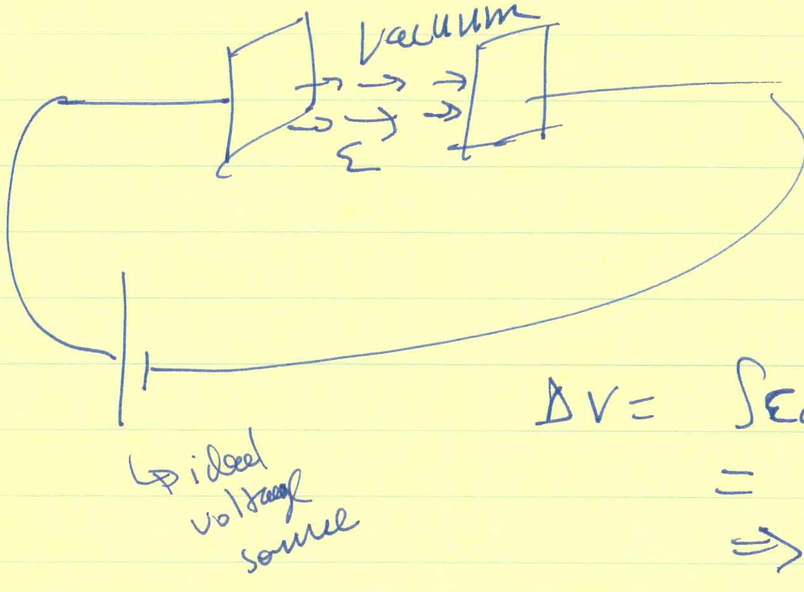
$$V_{ab} \equiv \frac{dw}{dq}$$

$$W = F \cdot x = q \mathbf{E} x$$

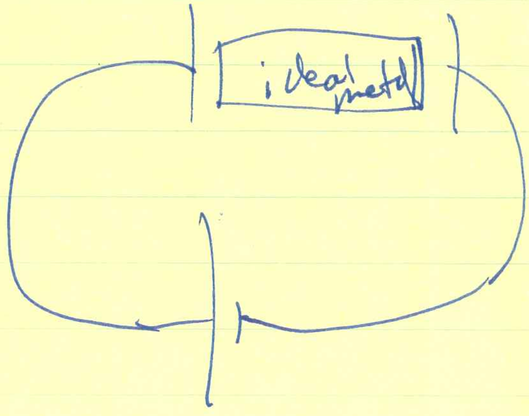
$$\frac{dw}{dq} = \mathbf{E} x = \int \mathbf{E}\, dx$$

Some physical examples:

Serway page 767



$$\Delta V = \int \mathcal{E}\,dx$$
$$= \mathcal{E} L$$
$$\Rightarrow \mathcal{E} = \frac{\Delta V}{L}$$



~~th~~ not possible.

~~Battery~~ Source forces ΔV but $\mathcal{E}=0$ everywhere. Even an ideal voltage source cannot make it happen for ideal metal.