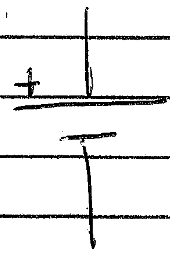
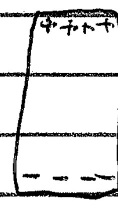
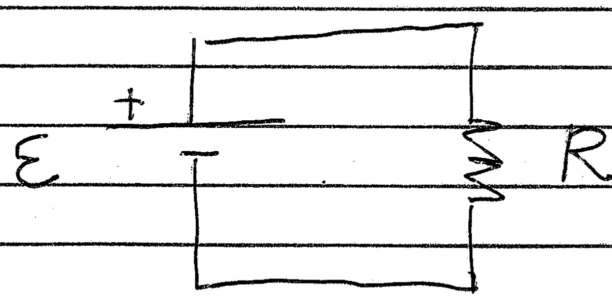
① Phys 1402 2015-09-15 Lec 6

HW2 Thu 9/24
Exam 1 Tue 9/29





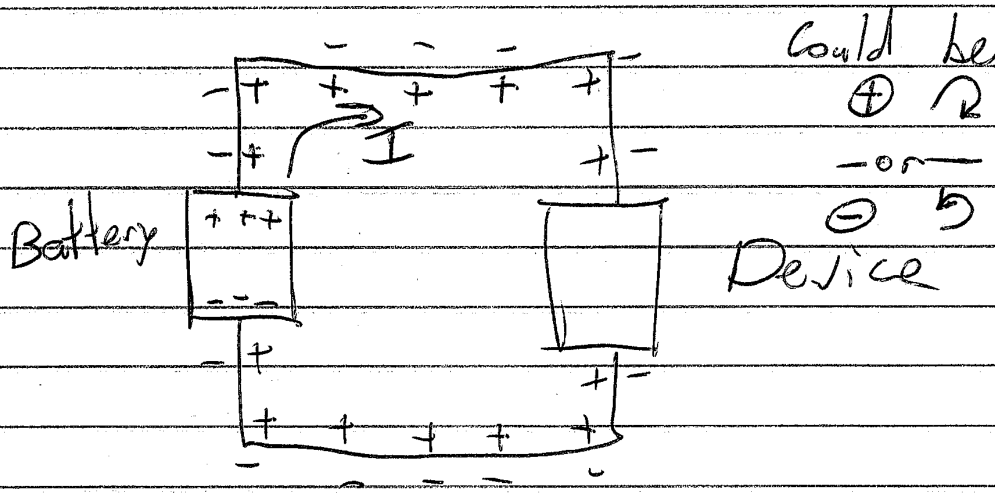


Apply a voltage $\mathcal{E}$ to a resistor R, current I flows.

Ohm's Law: $V = IR$

V = voltage across resistor ($\mathcal{E}$ above)
R = resistance (Const if Ohmic)
I = current that flows

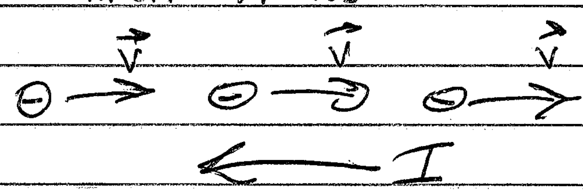
$$I = \frac{\Delta Q}{\Delta t}$$



Charges are balanced.
Current is the flow of one (or the other) type of charge.

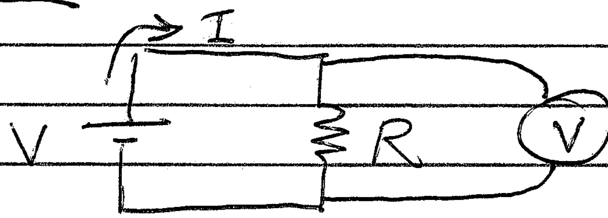
⊕ charges form current in the same dir they flow.

⊖ charges form current opposite to their flow.



Measuring Electrical Quantities

Voltage: Working Circuit



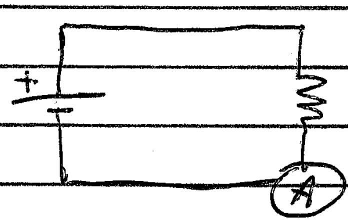
To measure V, our meter has no I.

$$V = I R_{meter}$$

Voltmeter has a huge R_{meter}.

No current flows thru voltmeter.

Current: Must break the circuit



Ammeter is part of the current path.

To measure I, our meter has no V.

$$V = I R_{meter}$$

Ammeter has tiny R_{meter}

No voltage exists across meter.

Power is the flow of energy

$$P = \frac{\text{Energy}}{\Delta t} = \frac{\text{Charge}}{\Delta t} \frac{\text{Energy}}{\text{Charge}}$$

$$P = IV$$

Out of $I, V, R, P,$ we have 2 eqns.

$$V = IR \qquad P = IV$$

Ex: 60 W Light bulb designed for 120 V power supply.

$P = 60\,W$
$V = 120\,V$

$$(60\,W) = (120\,V)\,I \rightarrow I = 0.5\,A$$

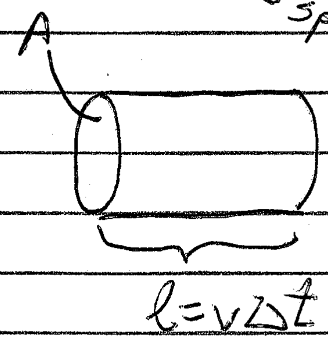
$$(120\,V) = (0.5\,A)\,R \rightarrow R = 240\,\Omega$$

$$P = I^2 R = \frac{V^2}{R}$$

↑ Tells us ~~of~~ power lost in a wire.

Physics of Flow

Vol flow Rate $= v\,A$
(m^3/s) — v = speed (m/s), A = cross-section Area (m^2)



$Vol = A\ell$
$= A v \Delta t$
$\frac{Vol}{\Delta t} = vA$

Mass Flow Rate $= \rho v A$ — ρ = density in (kg/m^3)

Particle Flow Rate $= \eta v A$ — η = particle dens $(\#/m^3)$

Charge Flow Rate $= q\,\eta\, vA$

$$I = e\eta v A$$

Ex: $\eta = 10^{28}\ 1/m^3$
$e = 1.6 \times 10^{-19}\ C$
$A = \pi r^2 = \pi (0.001\,m)^2 = 3.1 \times 10^{-6}\ m^2$
$I = 1.0\ A$

$v = 0.0002\ m/s = 0.2\ mm/s$
"Drift Velocity"

People Flow rate $= \frac{\text{People}}{m^2} \, v \, (\text{Door Width})$

Resistivity $\quad R = \rho \frac{l}{A}$

(ρ ← resistivity)

Thermal Coefficient

$$R = R_0 \left(1 + \alpha (T - T_0)\right)$$

$$\frac{R}{R_0} = 1 + \alpha (T - T_0)$$

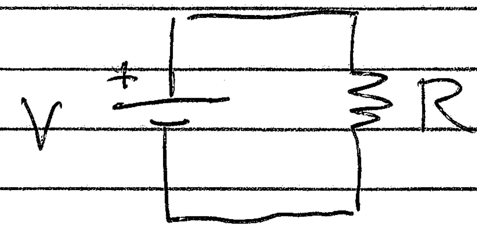
$$\frac{R}{R_0} - 1 = \alpha (T - T_0)$$

$$\frac{R - R_0}{R_0} = \alpha (T - T_0)$$

$$\frac{\Delta R}{R_0} = \alpha \Delta T$$

Fractional Change in resistance = (Temp Change)(Temp Coeff)

$\alpha = 0.01\ {}^\circ F^{-1}$ means 1% for every °F



$$I = \frac{V}{R}$$

$$P = IV = \frac{V^2}{R}$$

Power heats the resistor.

If α is $\oplus$: $\frac{\Delta R}{R_0} = \alpha \Delta T$

- ΔR is $\oplus$
- R increases
- P decreases
- System finds equilibrium

If α is $\ominus$: ΔR is $\ominus$

- R decreases
- P increases
- System heats more!
- Thermal Runaway.