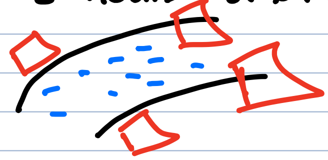
ch 9

setting: The metrodome, Minneapolis Oct 1987

3 hours before Game 2 of the World Series



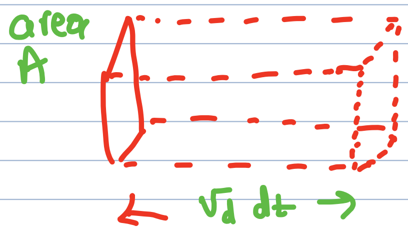
kiosks for popcorn, programs

My typical unimpeded speed is 10^6 m/s

but my average drift velocity $\vec{v}_d \sim 0$ m/s

The "people current" when pulled by the "field" is $v_d \sim 10^{-4}$ m/s

passes through a door in time dt



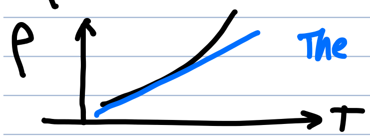
people in this volume is $\frac{\text{people}}{\text{volume}} \cdot \text{volume}$

$\approx \frac{\text{people}}{\text{volume}} v_d\, dt\, A$

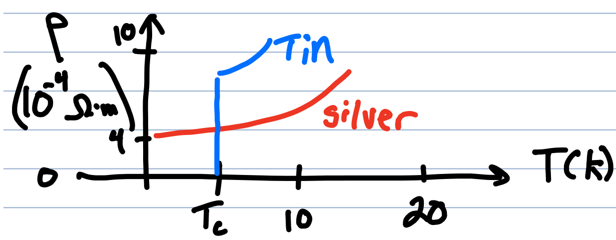
$\rightarrow \frac{\text{people}}{\text{time}} \approx \text{people current} = \frac{\text{people}}{\text{volume}} v_d \cdot A$

On an atomic level, faster speeds → increased temperature

$\rho(T) \propto$ change in T: $\rho(T) = \rho_0 + \rho_0 \alpha (T - T_0)$



The relation isn't perfectly linear, but it's a reasonable approximation for a range of ~ 100 °C



Q: Why does a light bulb turn on instantly, even though $v_d \sim 10^{-4}$ m/s

→ e.g. an e^- takes ~ 3 hours nearly to travel 1m!

A: 

only need e⁻s at the ends to move into the bulb

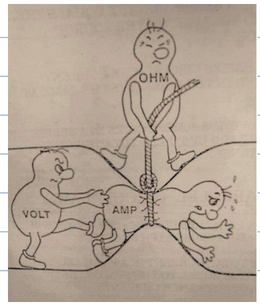
$$\boxed{R \propto \frac{\rho L}{A}}$$

R = resistance
ρ = resistivity

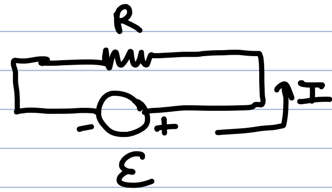
A = cross-sectional A
L = length

Think of "how much flow" vs "how much push"

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



I = current



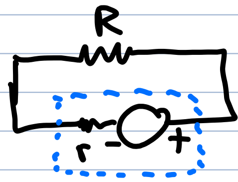
DC circuits

V : potential drop across resistor
R : resistance of resistor
ε : potential provided by battery
I : current

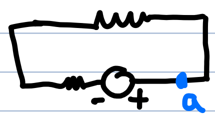
In this case, all of the battery's potential is "lost" in traversing the resistor: $V = \varepsilon$

A more realistic depiction:

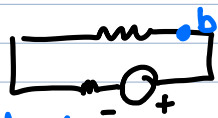
batteries have internal resistance



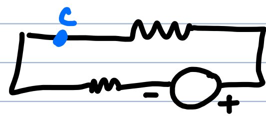
Q: what is current through R?



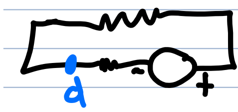
$V_a = \varepsilon$



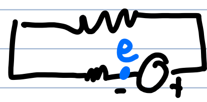
$V_b = V_a = \varepsilon$



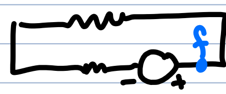
$V_c = V_b - IR$
$= \varepsilon - IR$



$V_d = V_c = \varepsilon - IR$



$V_e = V_d - Ir$
$= \varepsilon - IR - Ir$

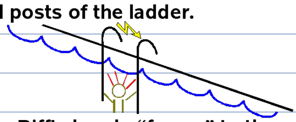


$V_f = V_e + \varepsilon = 2\varepsilon - IR - Ir$

also, $V_f = V_a = \varepsilon \Rightarrow 2\varepsilon - IR - Ir = \varepsilon \Rightarrow I = \frac{\varepsilon}{R + r}$

Alternatively: $\sum V = 0 \rightarrow \mathcal{E} - IR - Ir = 0 \rightarrow I = \frac{\mathcal{E}}{R+r}$

Biff and Sasha are swimming in a pool. Sasha thought it would be "funny" to apply a 20 V potential difference across the two metal posts of the ladder.



From initial scenario: $R = \frac{V}{I} = \frac{20V}{20mA} = 1000\Omega$

Unfortunately, Biff's hands "freeze" to the posts: the current through him is 20 mA.

$\rightarrow \Delta V = IR = (0.1A)(1000\Omega) = 100V$ A

What ΔV would produce 100 mA? (thus inducing ventricular fibrillation)

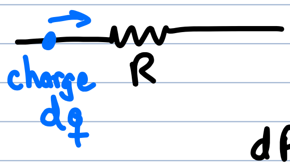
a) 100 V
b) 1 V
c) 1,000 V
d) 500 V

$20V = 20mA \cdot R$

$?V = 100mA \cdot R$

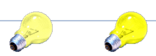
Power A 20mA current thanks to Sasha can affect you.

$\rightarrow$ energy is transferred, but at what rate?



work to push charge dq through resistor is $\Delta V\, dq$

$$d\text{Power} = \frac{dW}{dt} = \frac{\Delta V dq}{dt} = \Delta V \cdot I \qquad \boxed{P = IV} = I(IR) = I^2 R = V^2/R$$



50 W 100 W

What is the resistance ratio of a 50 W bulb and a 100 W bulb? R_{50}/R_{100} =

a) 1 / 1
b) 2 / 1
c) 1 / 2
d) 0 / ∞