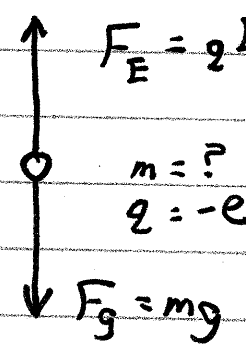
① Phys 1402   2014-09-16

Millikan Oil Drop



$F_E = F_g$

$qE = mg$

↑

$m = \rho V_{ol}$

↑

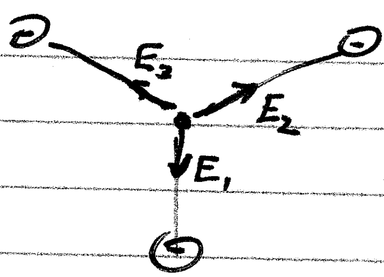
$V = \frac{4}{3}\pi r^3$

ρ = density = $\frac{\text{mass}}{\text{volume}}$

CASA Tutors

Math Lab: Frank, Jay

Science Lab: Ruben, see schedule



Each $E = \frac{kq}{r^2}$ w/ same q, r.

Equally spaced, so total $\vec{E} = 0$ N/C.

②

DC Circuits

Battery (Ideal) – Causes a constant voltage by forcing current through a circuit.

Battery (Realistic) – Runs out of charge, and it has internal resistance.

$$\mathcal{E} = V_{out} + \underbrace{I R_{int}}$$

Total Voltage ($\mathcal{E}$)

Usable Voltage (V_{out})

Wasted Voltage ($I R_{int}$)

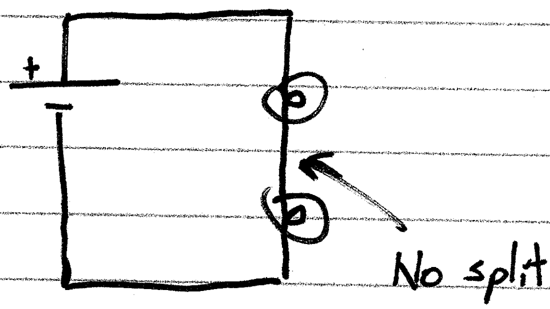
Resistance – Determines how much current flows with a given push (Voltage).

$$V = I R$$

I → Current in amps (A)

(3)

Series



Same Current in both bulbs.

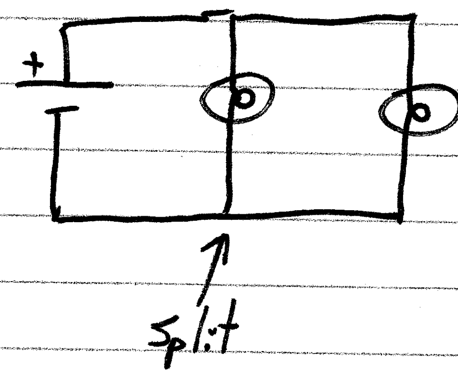
$I_{net} = I_1 = I_2 = \ldots$

The individual charges pick up energy from the batt and drop it in the loads. Each charge <u>must</u> drop all of its energy.

Since $V = \frac{\text{Energy}}{\text{Charge}}$

$V_{net} = V_1 + V_2$

Parallel



Current splits & rejoins.

$I_{net} = I_1 + I_2 + \ldots$

(Same argument)
But each charge goes thru bulb 1 <u>or</u> bulb 2.

$V_{net} = V_1$

$V_{net} = V_2$

Series Resistance

$$V_{net} = V_1 + V_2 + \ldots$$

$V_1 = IR_1$, $V_2 = IR_2$

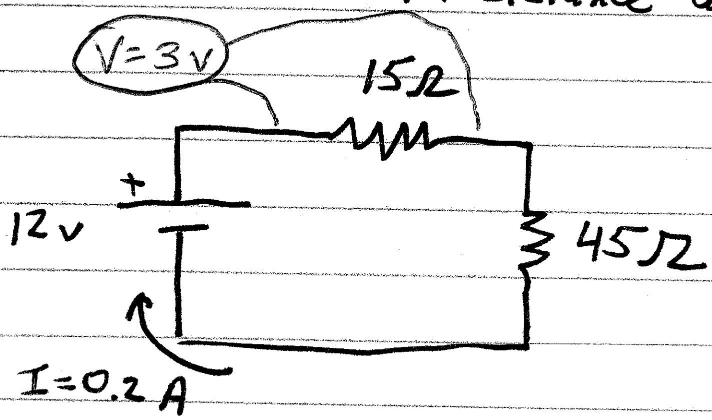
$$V_{net} = IR_1 + IR_2 + \ldots$$

$$= I(R_1 + R_2 + \ldots)$$

$$= I R_{net}$$

Series: $R_{net} = R_1 + R_2 + \ldots$

- R's always positive
- R_{net} bigger than any R_i
- A huge R_i dominates and $R_{net} \approx R_{huge}$
- Internal resistance acts like it's in series.



$R_{net} = 60\Omega$

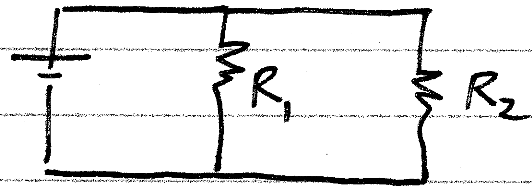
$$I = \frac{V}{R} = \frac{12v}{60\Omega} = 0.2\,A$$

$V_{15} = (0.2A)(15\Omega) = 3.0\,V$

$V_{45} = (0.2A)(45\Omega) = 9.0\,V$

Total 12 V

Parallel Resistance



$V = V_1 = V_2 = \ldots$

Separate Equations:

$I_1 = \frac{V}{R_1}$

$I_2 = \frac{V}{R_2}$

With a parallel circuit hooked to a voltage source, devices run independently. This models household electrical systems.

$$I_{net} = I_1 + I_2 + \ldots$$

$$= \frac{V}{R_1} + \frac{V}{R_2} + \ldots$$

$$= V\left(\frac{1}{R_1} + \frac{1}{R_2} + \ldots\right) = V/R_{net}$$

Parallel: $\frac{1}{R_{net}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

- R_{net} always lower than any R_i
- A tiny R_i dominates, so $R_{net} \approx R_{tiny}$
- <u>Short Circuit</u> : $R_i = 0 \Rightarrow R_{net} = 0$

Electricity in biology

Electric Shock - directly caused by current.

~1 mA	can feel it
~10 mA	strong shock / twitching
~30 mA	heart damage possible

A triple-A battery can provide ~0.1 A current, but doesn't hurt. Why?
- The voltage is too low.

Lightning behaves weird!
Even with parallel current paths, a significant current can flow other ways.