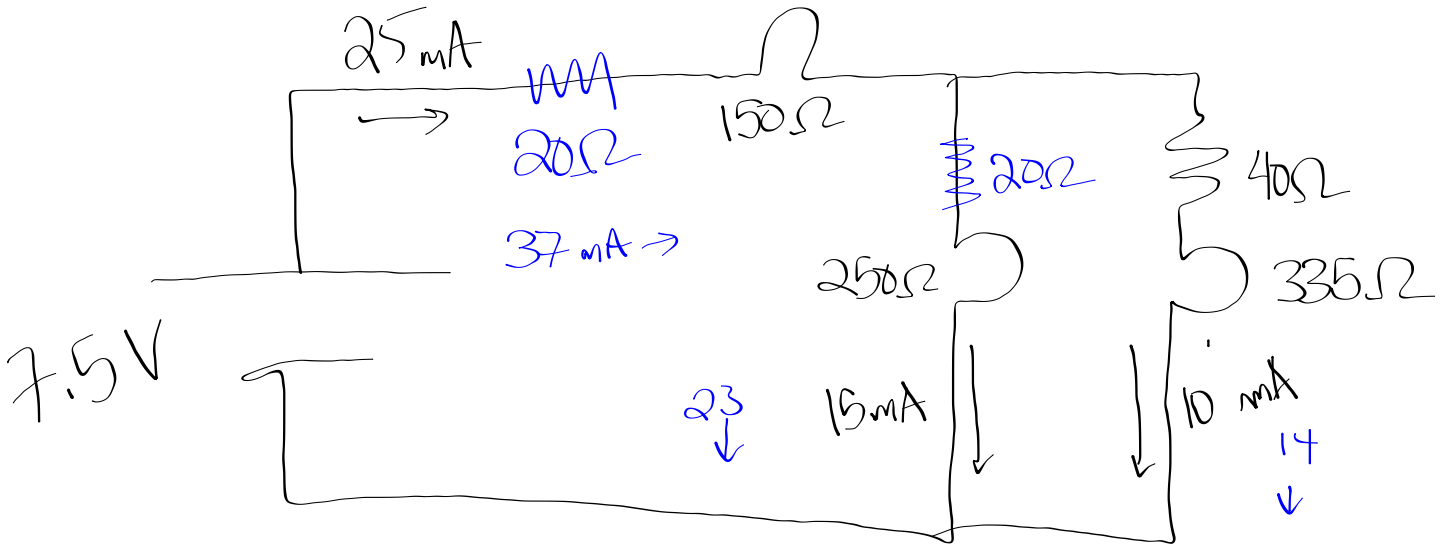
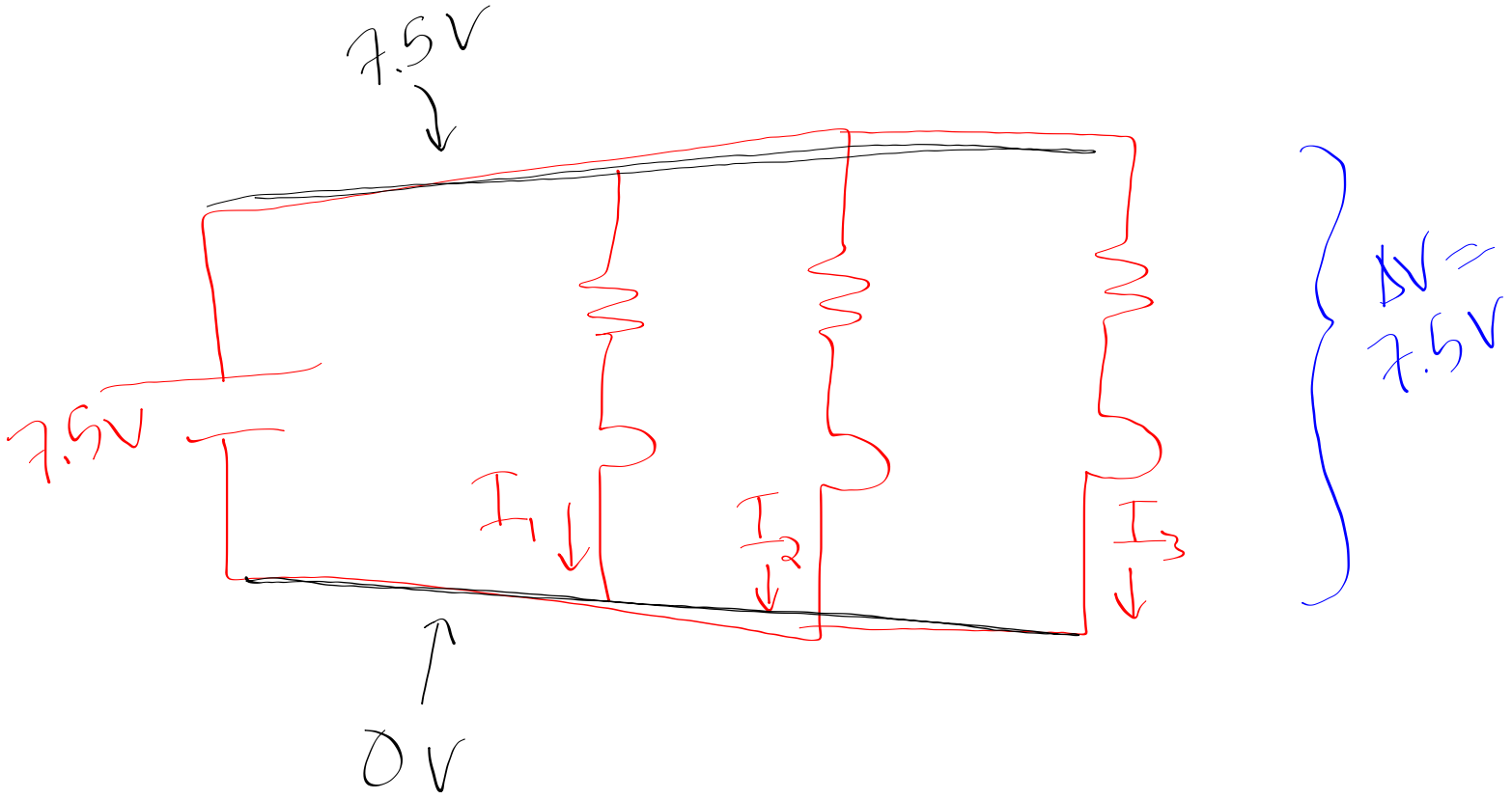
CIRCUIT LAB:

- Predictions were hard – you can still analyze the circuit with math
- Big problem: LED's have variable resistance, over time, as I increases, R will decrease
  - One (imperfect) solution is to put resistors in front of each LED
  - A better solution is to put LED's in parallel paths


25 mA
20Ω
150Ω
37 mA
20Ω
40Ω
250Ω
335Ω
7.5V
23
15mA
10 mA
14


7.5 V
7.5V
I_1
I_2
I_3
0 V
ΔV = 7.5V

Kirchhoff's Rules:

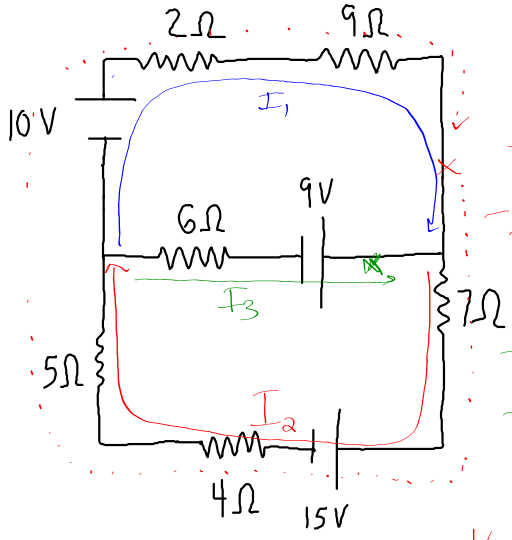
JUNCTION RULE: The total current entering any junction must equal the total current leaving any junction within a circuit.

LOOP RULE: For any closed loop within a circuit, the sum of all of the voltage drops across all of the components along this loop must sum to zero total volts. (Voltage sources count as voltage INCREASES if you're moving from - to +.)

1. Label currents (include direction)
2. Use junction rule to make equations
3. Use loop rule + Ohm's Law for additional equations

What are the currents through the 6 Ohm, 9 Ohm, and 7 Ohm resistors? What is the potential difference (i.e., voltage drop) across the 5 Ohm resistor?

$V=IR$



$I_2 = I_1 + I_3$

$-V_7 - 15 - V_4 - V_5 + 10 - V_2 - V_1 = 0$

$-I_2(7) - 15 - I_2(4) - I_2(5) + 10$

$-I_1(2) - I_1(9) = 0$

$-I_2(7) - 15V - I_2(4) - I_2(5)$

$-I_3(6) + 9 = 0$

$-16I_2 - 6 - 6I_3 = 0$

$I_3 = \frac{16I_2 + 6}{-6}$

$-16I_2 - 5 - 11I_1 = 0$

$I_1 = \frac{16I_2 + 5}{-11}$

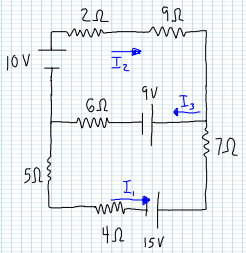
$I_2 = \frac{16I_2 + 5}{-11} + \frac{16I_2 + 6}{-6}$

$I_2 = -1.45I_2 - 0.45 + -2.67I_2 - 1$

$5.12I_2 = -1.45$

$I_2 = -0.283\ A$

Warm-Up: What are the currents in the 6 Ohm, 9 Ohm, and 7 Ohm resistors. What is the potential difference across the 5 Ohm resistor?



Multiple EMF's -- use Kirchhoff's Rules

① Guess What The Currents Will Be And Label.

(If You Guess The Current Negative)

② Apply The Junction Rule

@ Right Junction: $I_1 + I_2 = I_3$ (a)

③ Apply Loop Rule Until You Have Enough Equations T Solve For Your Unknowns:

Top Loop: $10 - 2(I_2) - 9(I_2) - 9 \quad 6(I_3) = 0$

$1 - 11I_2 \quad 6I_3 = 0$ (b)

Bottom Loop: $15 - 7(I_1) - 9 \_ 6(I_3) - 5(I_1) - 4(I_1) = 0$

$6 - 16I_1 - 6I_3 = 0$ (c)

④ Solve For Unknown Currents:

From (a): $I_3 = I_1 + I_2$

From (b): $1 - 11(I_2) - 6(I_1 + I_2) = 0$

$1 - 17I_2 - 6I_1 = 0$ (d)

From (c): $6 - 16I_1 - 6(I_1 + I_2) = 0$

$6 - 22I_1 - 6I_2 = 0$

$6 - 22I_1 = 6I_2$

$\frac{6 - 22I_1}{6} = I_2$ (e)