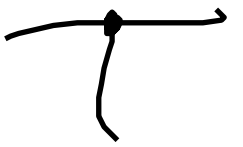
Circuit Problems

- Known. battery emfs
  resistances

  Solve for currents

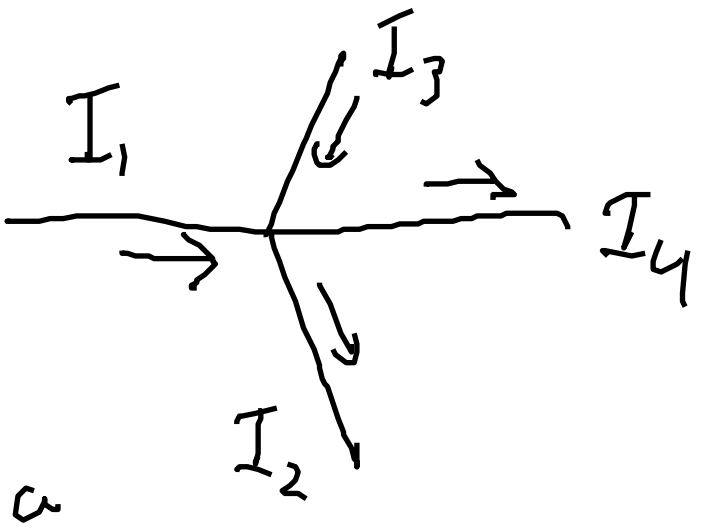
Kirchhoff's Laws

- junction rule
  for every junction,
  current in = current out



- loop rule
  total change of potential
  around any loop is zero.

Junctions



- for each junction, each wire has a different label and a direction

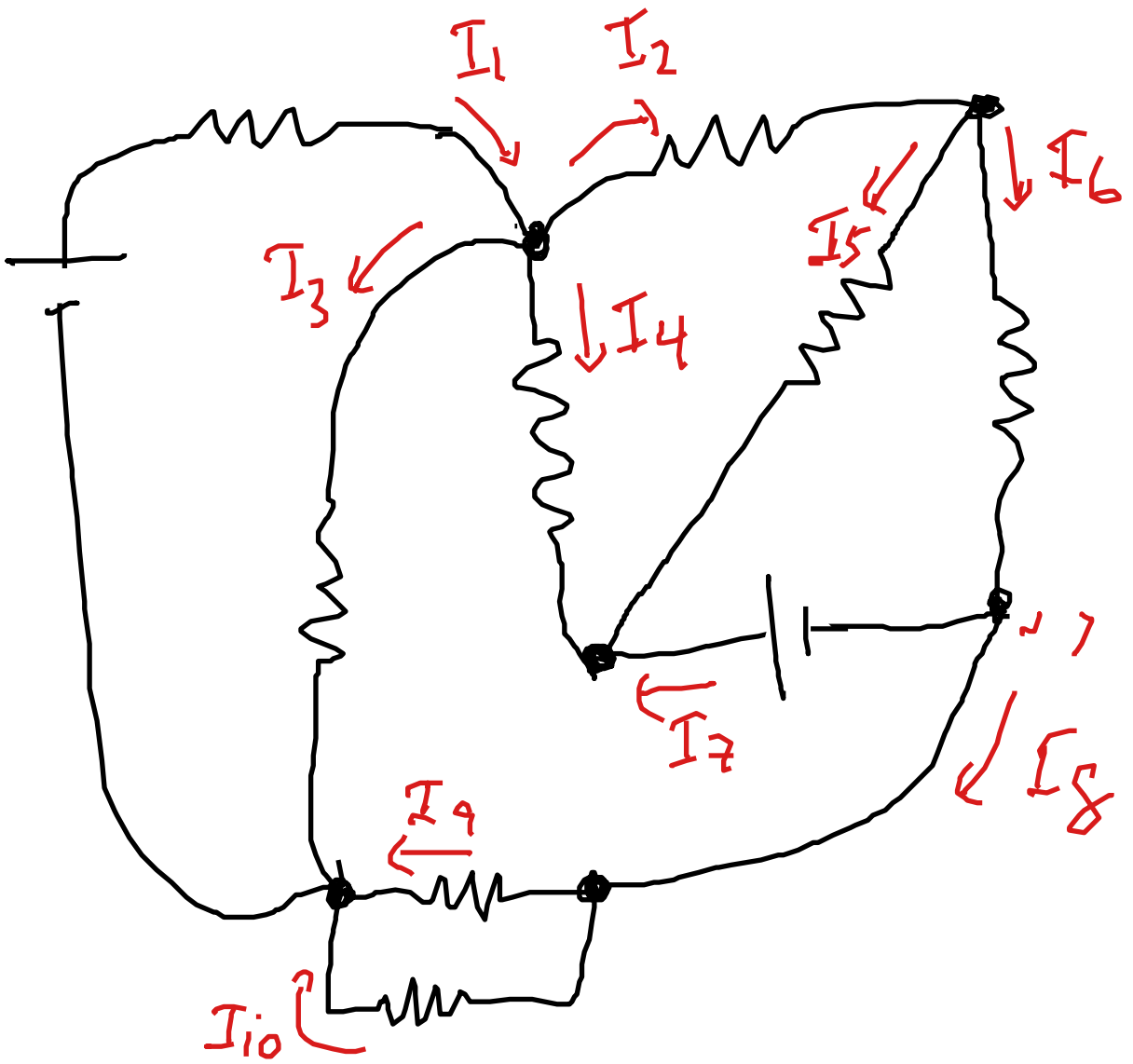
"Direction" is like a "positive axis"

(If a current turns out to be a negative number, then it actually goes in the opposite direction)

current in = current out

$$I_1 + I_3 = I_2 + I_4$$

Four unknowns, one equation



1) Identify currents.
(Use junctions: every wire at junction has a different label.)

Junction Rule gives us

1 equation per junction

① $I_1 = I_2 + I_3 + I_4$

② $I_2 = I_5 + I_6$

③ $I_4 + I_5 + I_7 = 0$

④ $I_6 = I_7 + I_8$

⑤ $I_{10} + I_9 + I_3 = I_1$

⑥ $I_8 = I_9 + I_{10}$

5 independent equations

1 is a reworking of the other 5

eg. ① $I_1 = I_2 + I_3 + I_4$

② ③

$I_1 = I_5 + I_6 + I_3 - I_5 - I_7$

$I_1 = I_6 + I_3 - I_7$

④

$I_1 = I_8 + I_3$

⑥

$I_1 = I_9 + I_{10} + I_3$

And I derived ⑤

At least one junction rule is redundant.

Loop Rule

total change in potential around a closed loop is zero

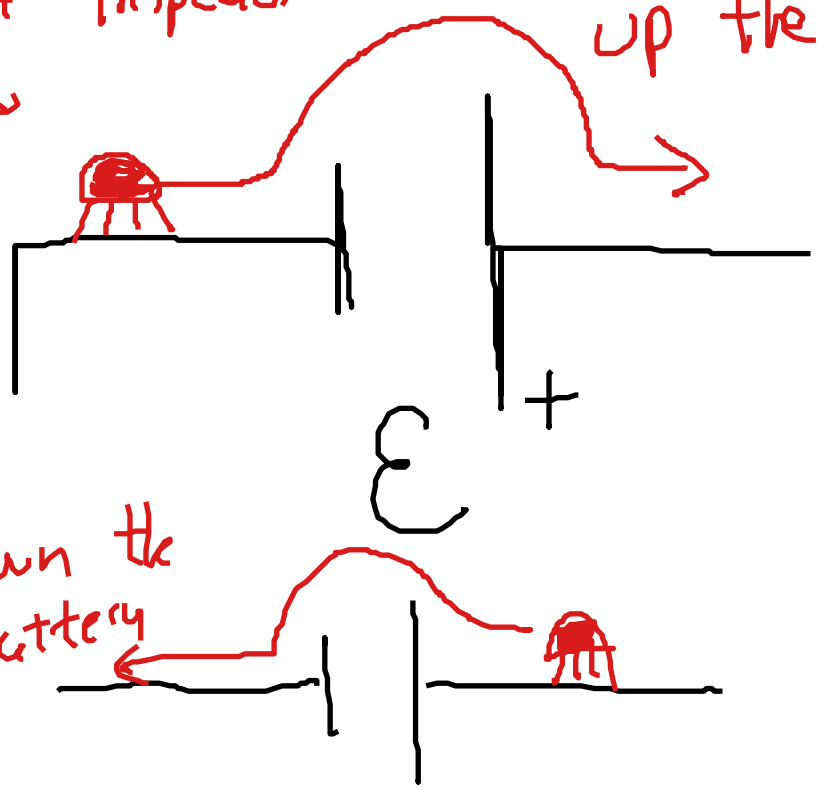
Tally Method

1) Pick a point and a direction in circuit.

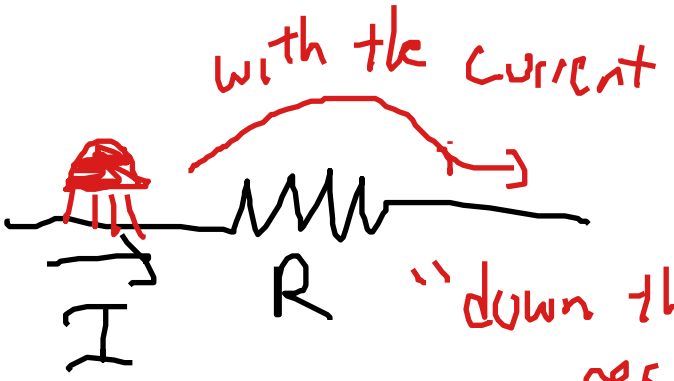
2) Travel through circuit keeping track of changes in potential (ΔV) (either $\mathcal{E}$ or IR)

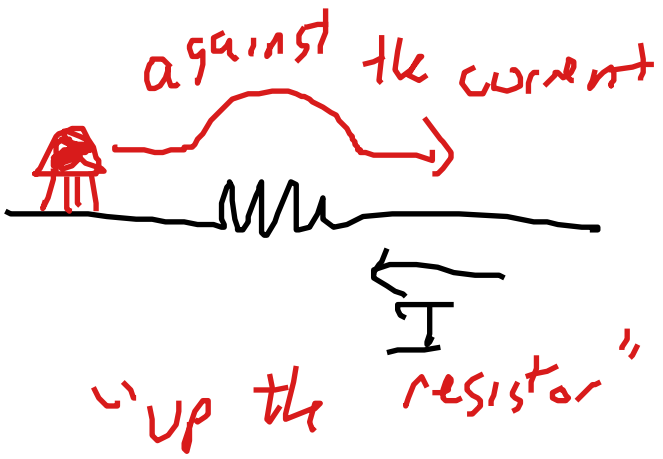
3) When you return to starting point, sum of changes $= 0$

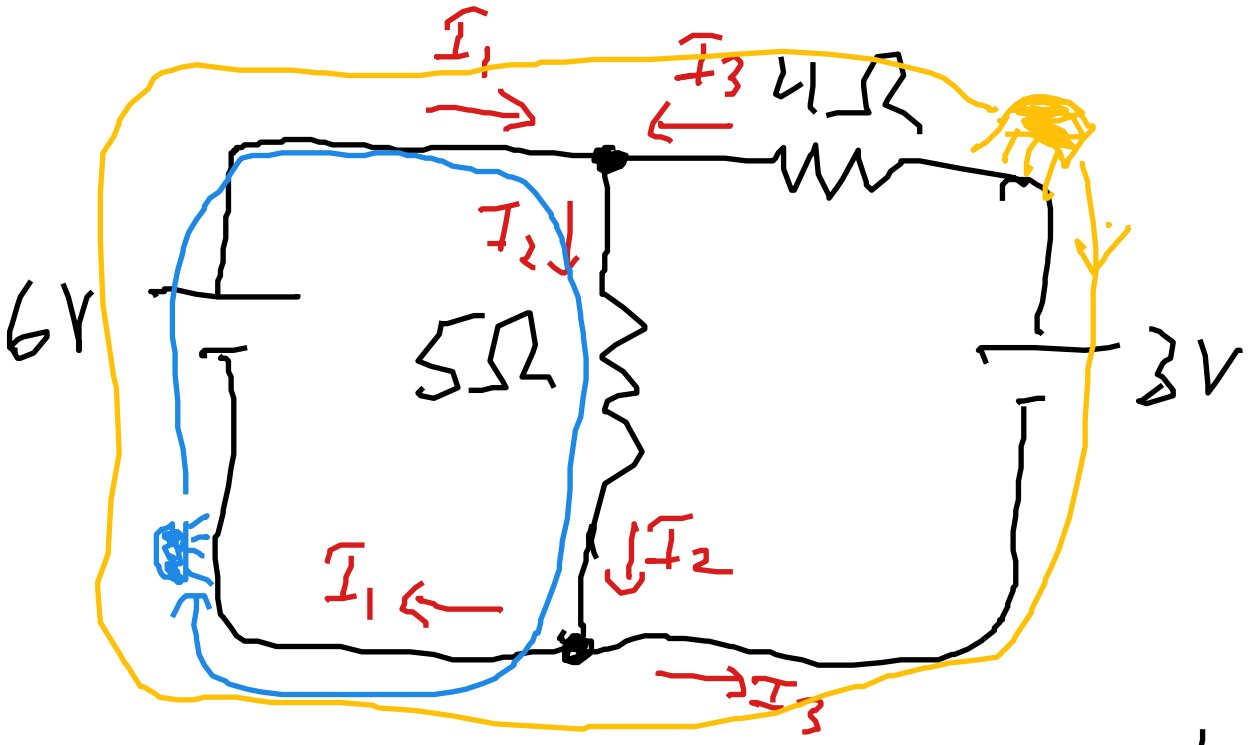
Circuit inspector



(for batteries, current direction doesn't matter)







1) Identify the currents, apply junction rule

$$I_1 + I_3 = I_2$$

$I_2 = I_1 + I_3$ ← redundant

2] Loop rule to get enough equations

$$+6 - 5I_2 = 0 \rightarrow I_2 = \frac{6}{5}$$

$$-3 + 6 + 4I_3 = 0$$