Electron Flow and Resistance:
Kirchoff, Thevenin, & Norton
Review: The Water Model

Session 1e of Basic Electricity
A Fairfield University E-Course
Powered by LearnLinc

Basic Electricity

Two Sections

- Electron Flow and Resistance
  - 5 on-line sessions
  - Lab
- Inductance and Capacitance
  - 5 on-line sessions
  - Lab

Mastery Test, Part 1

Basic Electricity (Continued)

- Text: "Electricity One-Seven," Harry Mileaf, Prentice-Hall, 1996, ISBN 0-13-889585-6 (Covers several Modules and more)
- References:
  - "Digital Mini Test: Principles of Electricity Lessons One and Two," SNET Home Study Coordinator, (203) 771-5400
  - Electronics Tutorial (Thanks to Alex Pounds at alex_tb@hotmail.com)
  - Electronics Tutorial (Thanks to Mark Sokos at sokos@desupernet.net)

Section 1:
Electron Flow and Resistance

- 0BJECTIVES: This section introduces five basic electrical concepts as well as the underlying atomic structure of electrical materials.
  - Conductance(G),
  - Resistance (R),
  - Current (I),
  - Power (P), and
  - Electromotive force (E) or voltage (V).

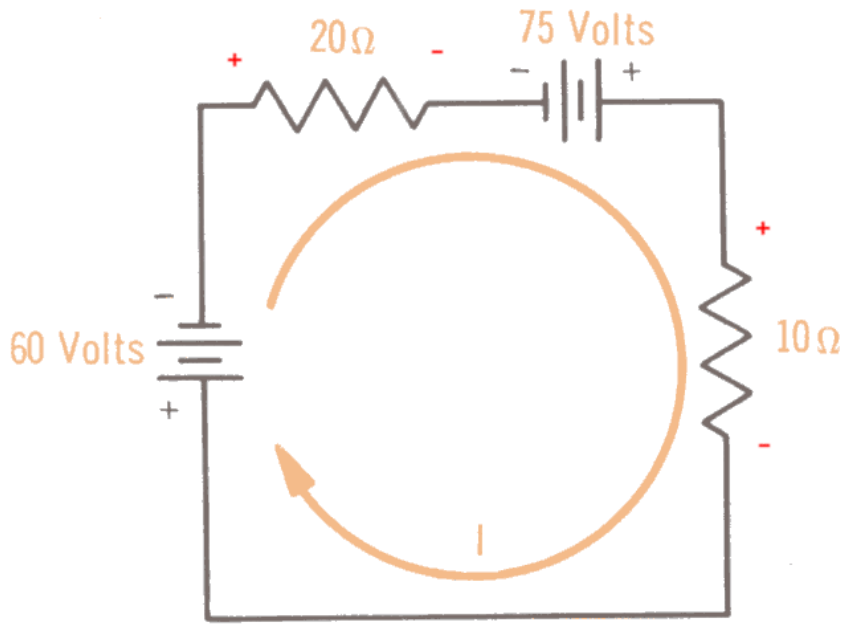
Section 1 Schedule:

Session a – 03/04	Atoms, Charge and Current	Text 1.1 – 1.39
03/06 & 03/08 were Math Tutorials	Conductivity (G), Electric Fields and Electromotive Force (EMF)	Text 1.40 – 1.68
Session b – 03/11	Resistance (R), Conductance (G), Ohms Law (Ω) & Power (Watts)	Text 2.1 – 2.52
Session c – 03/13 (lab - 03/16, sat.)	Resistors in Series and Parallel and Working with Equations	Text 2.53 – 2.98
Session d – 03/18	Series / Parallel Simplification Voltage and Current Dividers	2.99 – 2.115
Session e – 03/20	Kirchoff, Thevenin & Norton **Review: The Water Model**	2.116 – 2.133 **1.42, 1.63, 2.5, 2.129 Sokos**

Kirchoff's Voltage Law

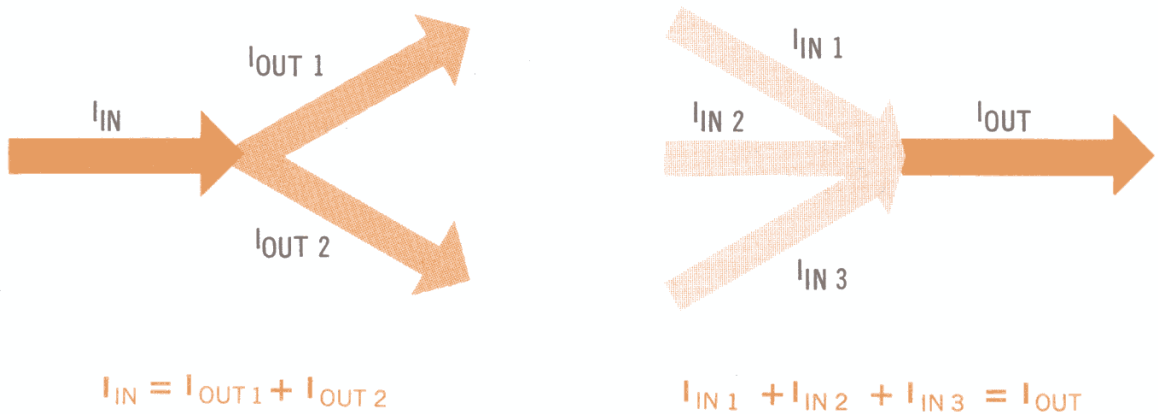
- The sum of all the voltages around a "loop" is zero
- Be careful to take signs into account
- Starting at the top left corner and going clockwise:

$$20 - 75 + 10 + 60 = 0$$



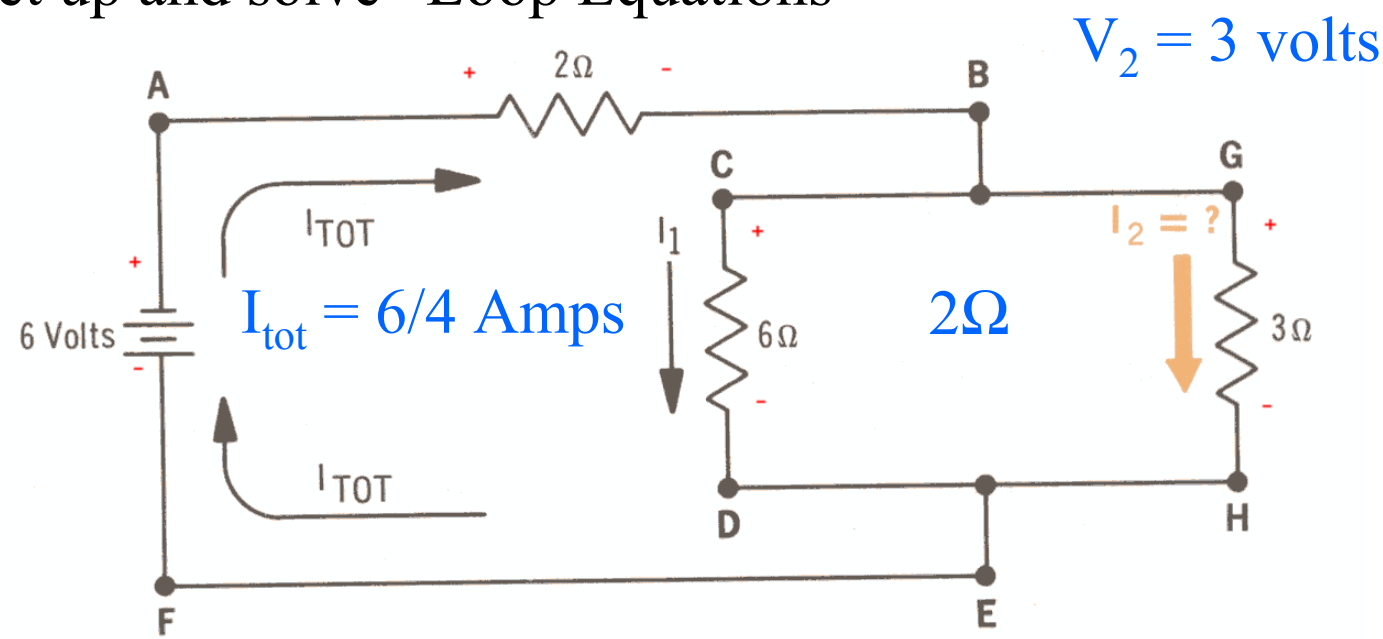
Kirchoff's Current Law

- The sum of all currents into a node equals zero.
- Again watch out for signs
  (direction of current flow)



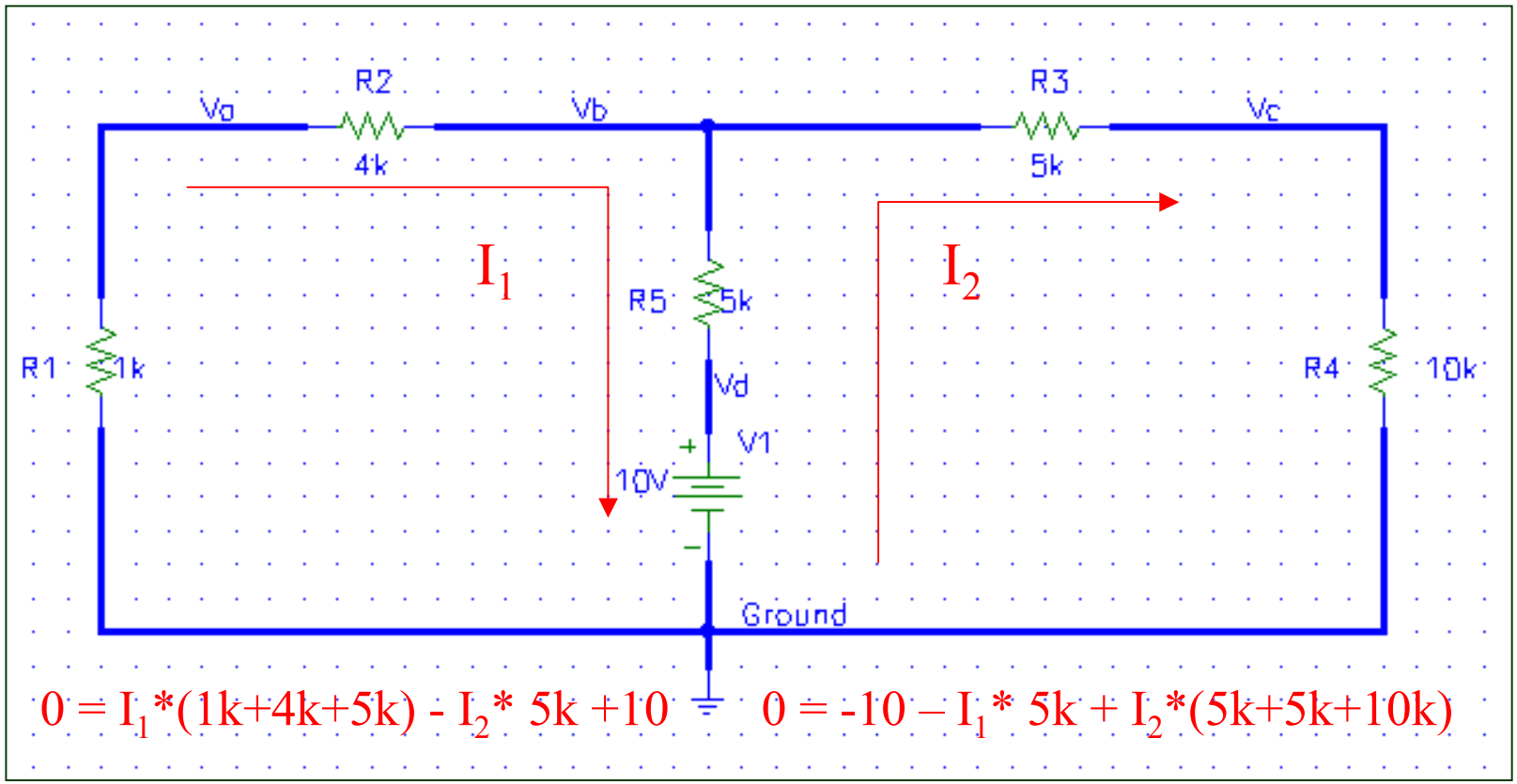
Using Kirchoff

- Use voltage divider or,
- Kirchoff's Voltage Law and a current divider, or
- Set up and solve "Loop Equations"



Kirchoff: Example 2

Using Loop Equations



Solving Loop Equations

$0 = I_1*(1k+4k+5k) - I_2*5k +10$ or

$-10 = 10k * I_1 - 5k * I_2$

$0 = -10 – I_1* 5k + I_2*(5k+5k+10k)$ or

$10 = –5k * I_1 + 20k * I_2$ or

$20 = –10k * I_1 + 40k * I_2$

Adding the bottom two simplified equations

$10 = 0 * I_1 + 35k *$ or

$I_2 = 10/35 = 2/7$ mA and by substituting into one of the above

$-10 = 10 * I_1 - 5 * 2/7$

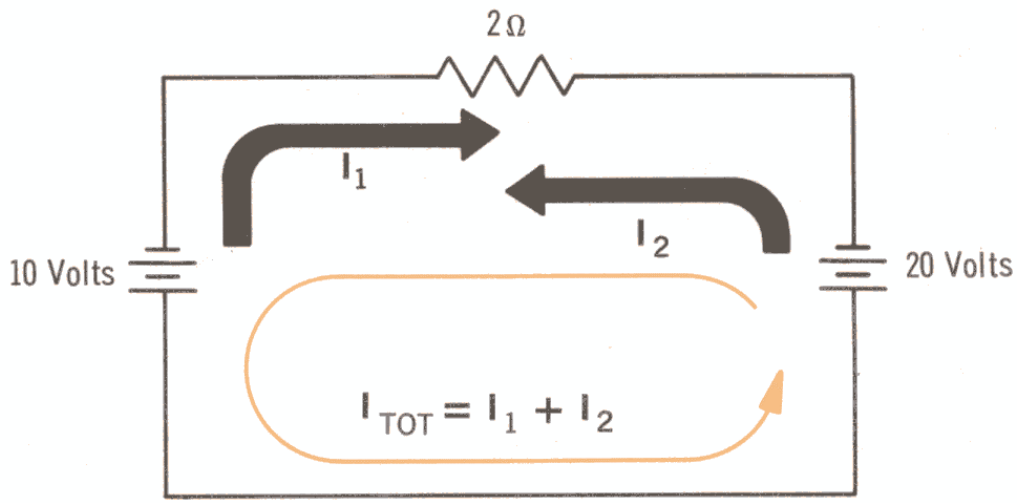
$10 * I_1 = -10 + 5 * 2/7 = -70/7 + 10/7 = -60/7$

$I_1 = -6/7$ mA

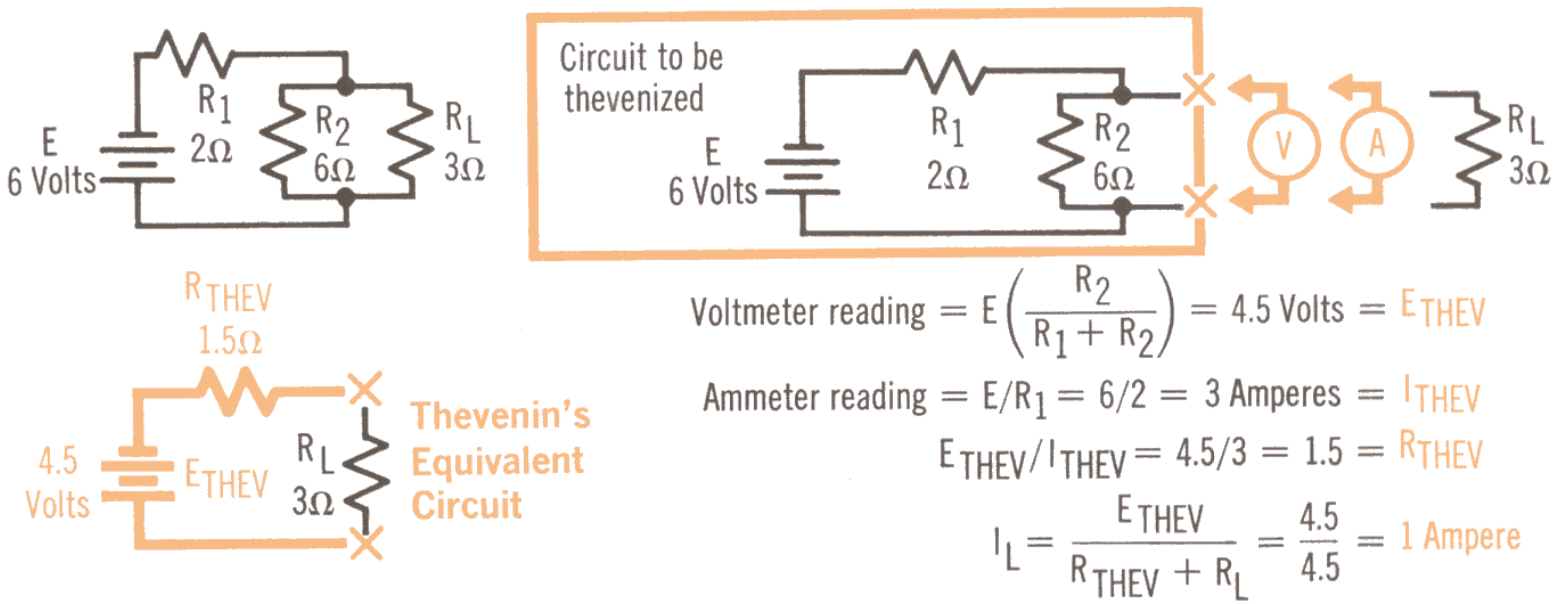
The minus sign just says that I_1 goes in the other direction

Superposition

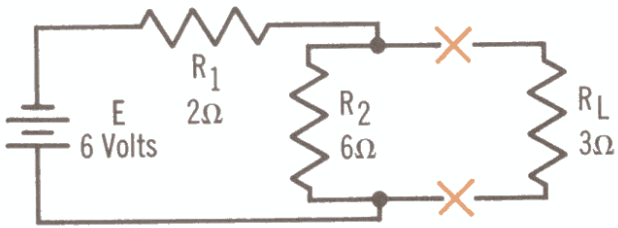
- Linear systems (R, L and C circuits are linear)
  - You can deal separately with each power source and then add the resulting currents (or voltages) to get the total result.



Thevenin Equivalent Circuits

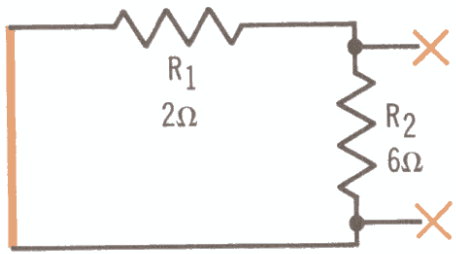


Thevenin
(Continued)

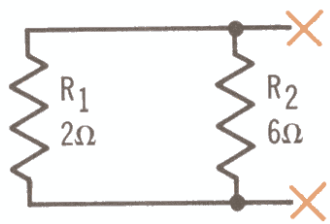


E_{THEV} is the voltage drop across R_2

$$E_{THEV} = E\left(\frac{R_2}{R_1 + R_2}\right) = 6\ (6/8) = 4.5 \text{ Volts}$$



When the source voltage is shorted, this circuit becomes

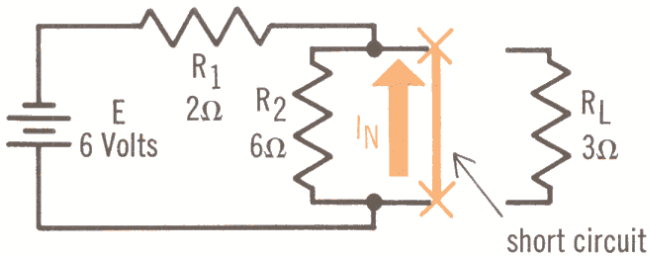


this circuit

and reduces to R_{THEV}

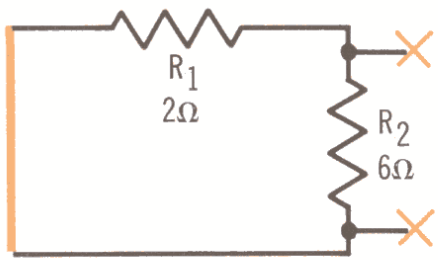
E_{THEV} and R_{THEV} are connected in series with R_L to produce Thevenin's equivalent circuit

Norton Equivalent Circuits

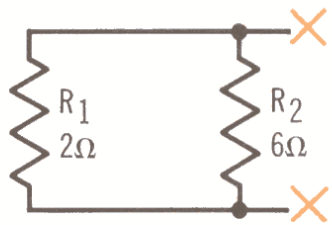


I_{NORTON} is the current through a short across the output terminals

$I_N = E/R_1 = 6/2 = 3$ Amperes



When the voltage source is shorted, this circuit becomes



this circuit

and reduces to R_{NORTON}

The constant current source, I_N feeds R_N and R_L in parallel to produce Norton's equivalent circuit

Next Class

- Review of all topics in chapters 1 and 2 of the text
- Quiz (via email to see how we're doing)