PATRIoT lab

Lecture 3 – Power supply

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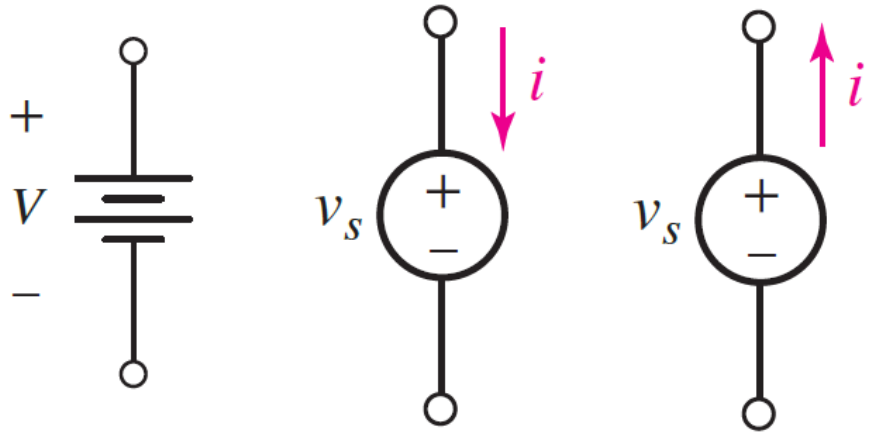
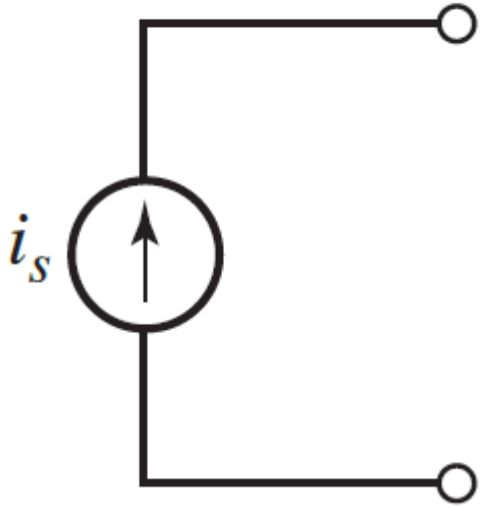
Voltage source

- An independent voltage source is characterized by a terminal voltage which is completely independent of the current through it
- The independent voltage source is an ideal source and does not represent exactly any real physical device, because the ideal source could theoretically deliver an infinite amount of energy from its terminals
- When the physical plate structure of the battery is suggested, the longer plate is placed at the positive terminal



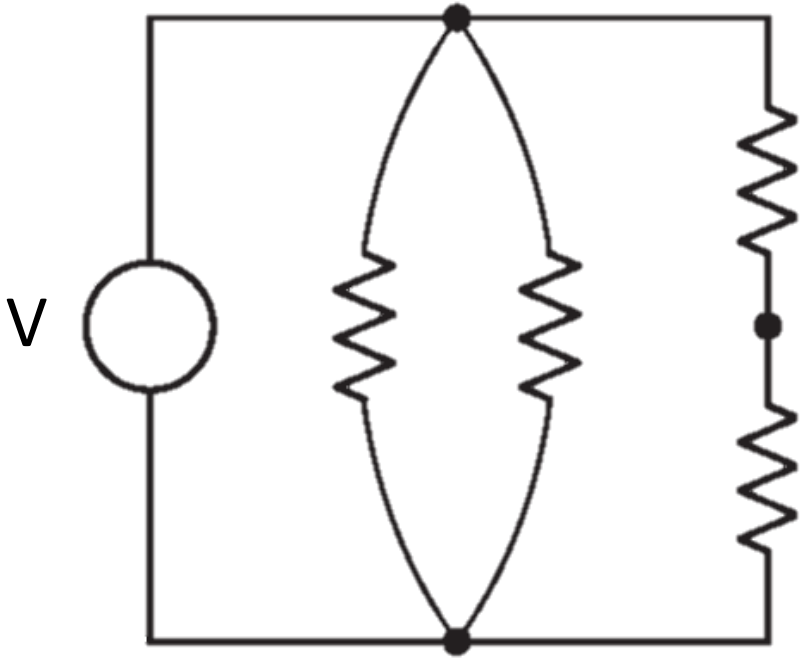
Current source

- In the independent current source, the current through the element is completely independent of the voltage across it
- Although most students seem happy enough with an independent voltage source providing a fixed voltage but essentially any current, it is a common mistake to view an independent current source as having zero voltage across its terminals while providing a fixed current
- We do not know a priori what the voltage across a current source will be—it depends entirely on the circuit to which it is connected



Electrical circuits

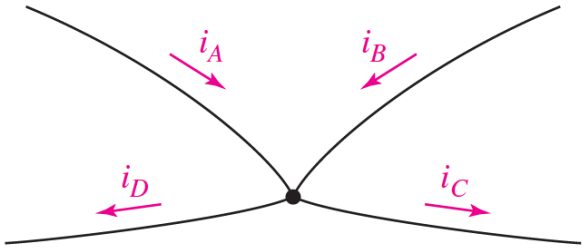
- Circuits are made using circuit **elements**, like resistors, sources etc.
- The elements will be connected by wires (sometimes referred to as “**leads**”), which have zero resistance
- A point at which two or more elements have a common connection is called a **node**
- While traversing a circuit, if no node was encountered more than once, then the set of nodes and elements that we have passed through is defined as a **path**
- If the node at which we started is the same as the node on which we ended, then the path is, by definition, a closed path or a **loop**



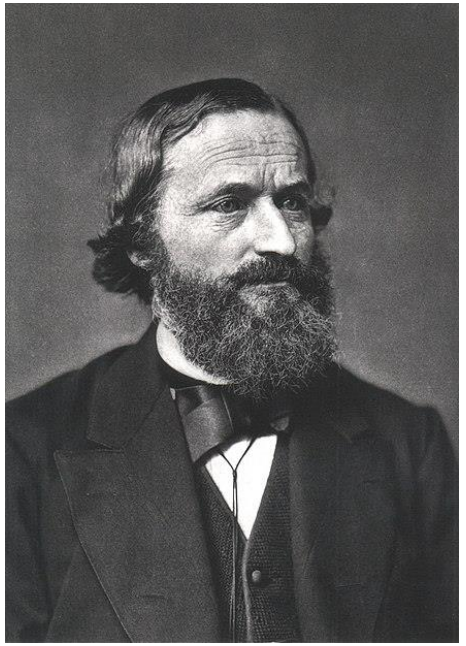
Kirchhoff's current law

The algebraic sum of the currents entering any node is zero

- This is a simple restatement of the law of conservation of charge
- Because charge cannot be destroyed, created, or stored at a node, the current leaving the node should be the same as that entering it
- This is also applicable to other type of flows such as fluid etc.



$$i_A + i_B - i_C - i_D = 0$$

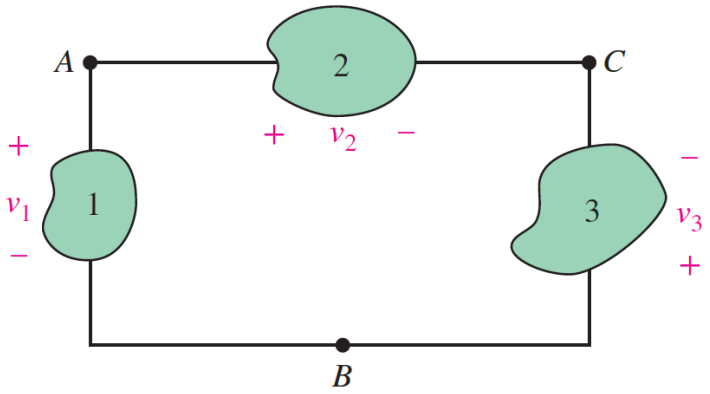


Kirchhoff formulated his circuit laws, which are now ubiquitous in electrical engineering, in 1845, while he was still a student!

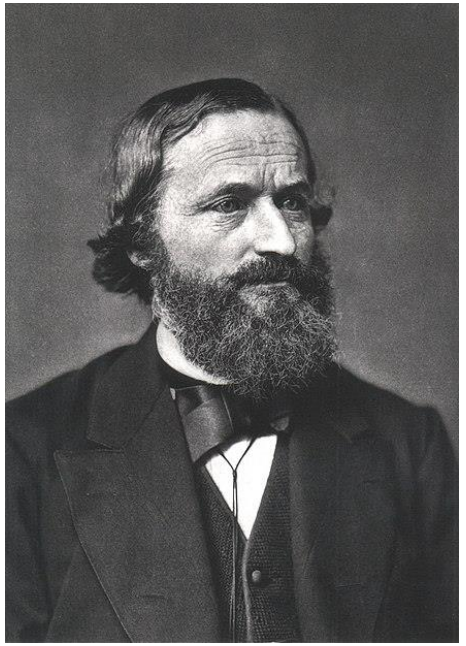
Kirchhoff's voltage law

The algebraic sum of the voltages around any closed path is zero

- This is a simple restatement of the law of conservation of energy
- The energy required to move a charge from point A to point B in a circuit must have a value independent of the path chosen to get from A to B
- Thus, the energy required to move a charge from A back to A, is zero



$$-v_1 + v_2 - v_3 = 0$$



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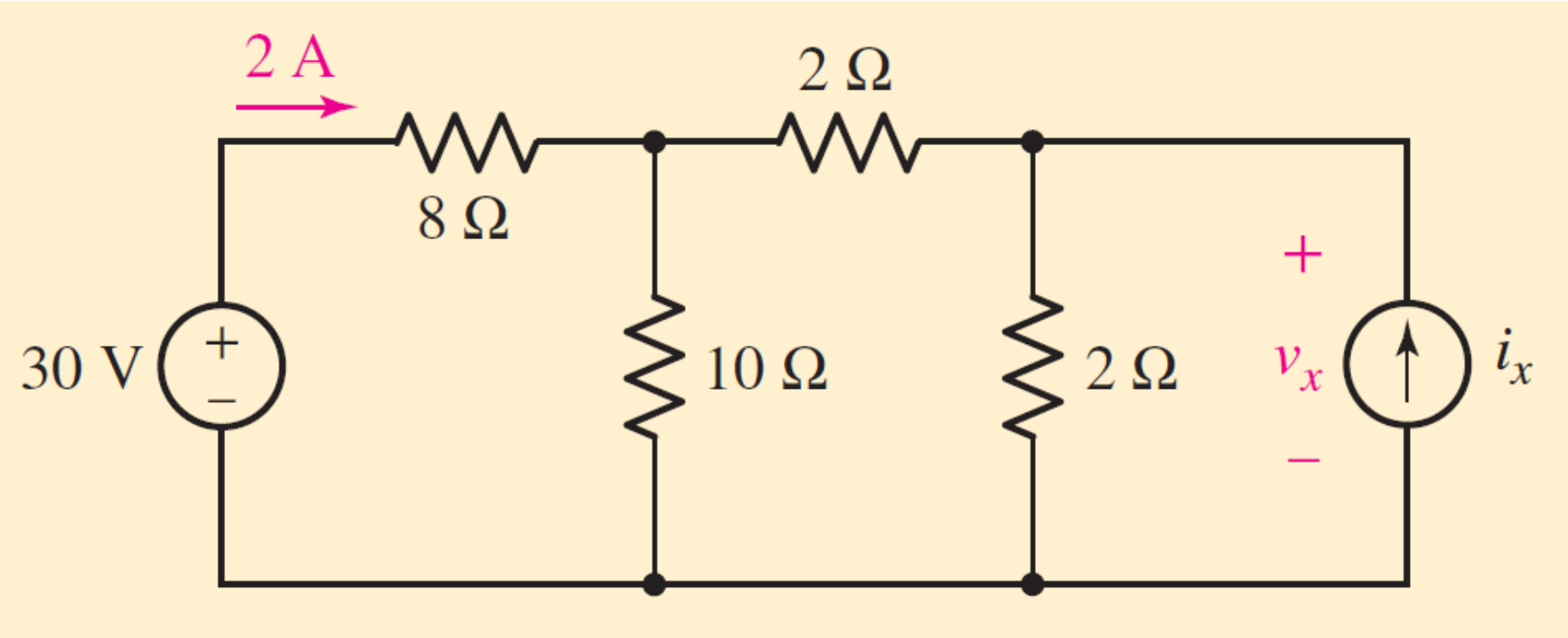
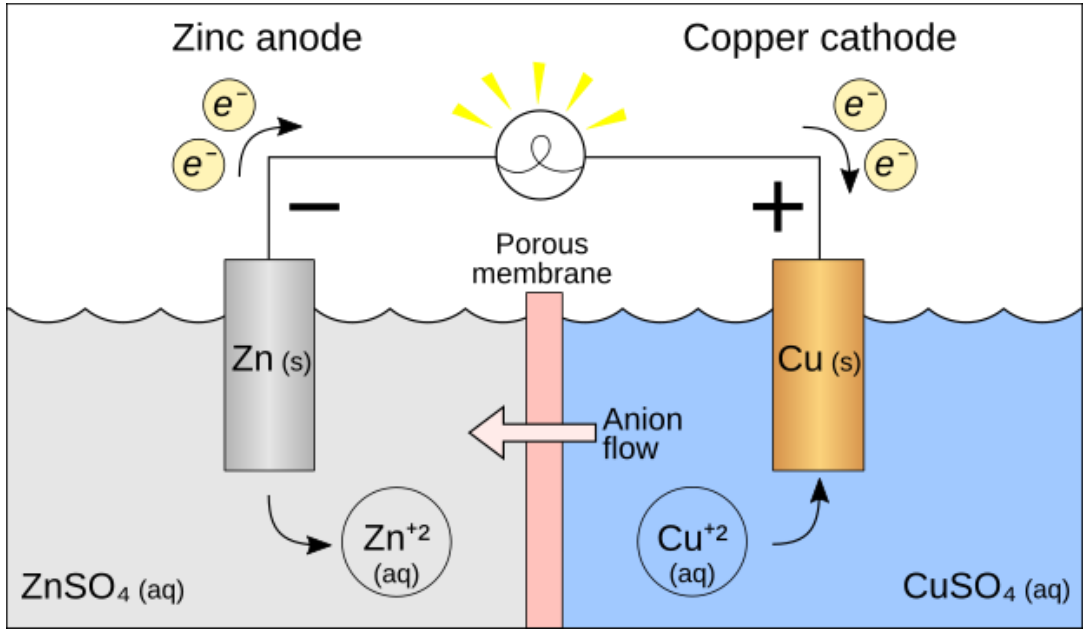
Example

- What is v_x and i_x?



Real power supplies

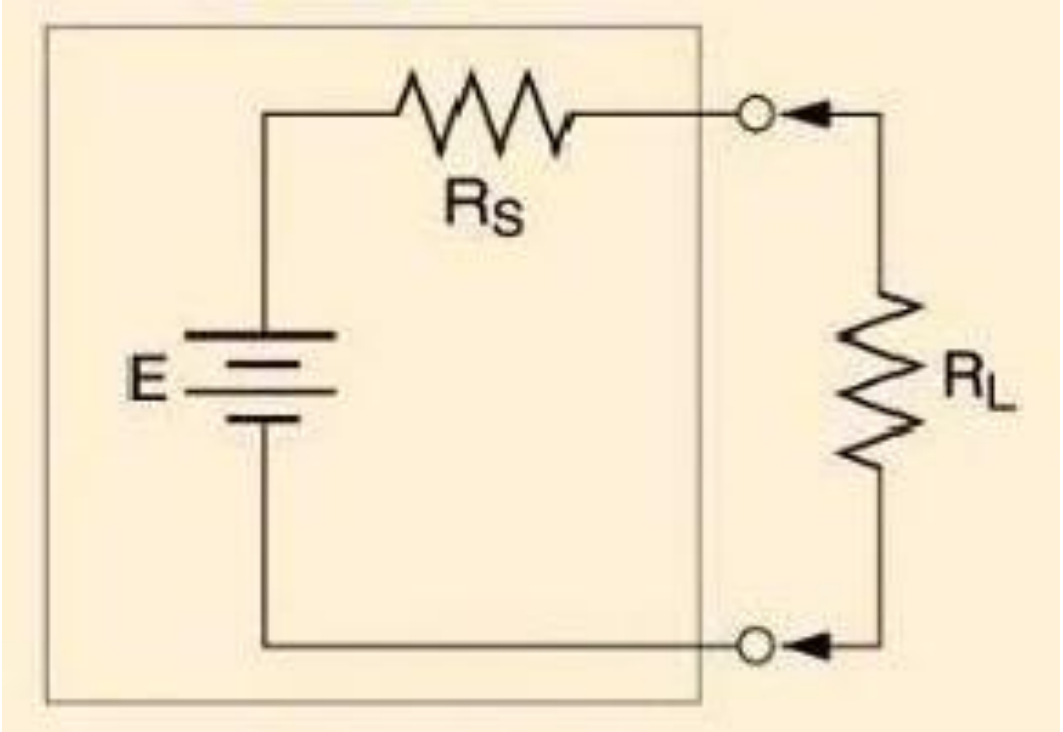
- In reality, we create voltage sources using chemical cells
- A **galvanic cell** is a fairly simple device consisting of two electrodes (an anode and a cathode) and an electrolyte solution
- These voltage sources have an internal resistance. Thus, voltage at the output is dependent on the load



Very imp: when we say “load” in electronics, we denote by resistance, but mean current, i.e., large load means large current (less resistance)

Real power supplies

- These voltage sources have an internal resistance. Thus, voltage at the output is dependent on the load
- Thus, real voltage sources are close to ideal voltage source if the load is very low
- Conversely, real voltage sources are close to ideal current source if the load is much higher
- The ideal behavior is still within a specific range of load



Sources in series/parallel

- Several voltage sources in series may be replaced by an equivalent voltage source having a voltage equal to the algebraic sum of the individual sources (from KVL)
- Parallel current sources may be combined by algebraically adding the individual currents, and the order of the parallel elements may be rearranged as desired (from KCL)
- What about voltage sources in parallel? And current sources in series?