

FREQUENTLY ASKED QUESTIONS

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Content Questions

What exactly is a voltage divider? It seems like just a potential at a point.

The term “voltage divider” refers to a circuit configuration in which there are two resistors (or resistor networks, or, as we will see later, two impedances) in series with a voltage source, and we are interested in the voltage between the resistors. We’ll see lots of examples of this kind of configuration.

The expression $V = \frac{R_2}{R_1 + R_2} V_0$, the “voltage divider equation”, relates the voltage V at the point between the two resistors to the voltage V_0 of the supply.

How does the Loop Rule in Kirchoff’s Laws come from energy conservation? Energy is added through the battery.

Yes, energy is added by the battery, but exactly the same amount of energy is dissipated by the resistors.

The gravitational analogy works well here for thinking about energy (both electric and gravitational forces are conservative forces which can be associated with a potential). The electric potential (voltage) is potential energy per charge. A charge going around a circuit is pumped “up” by a battery, then makes an “ohmic drop” through a resistor. This is like moving a ball up and letting it fall, in a closed loop under gravity. You supply energy to move the ball up, increasing its gravitational potential energy, but then exactly that amount of potential energy gets turned into kinetic energy as the ball falls back to the level at which it started.

In the electric circuit case, the battery increases a charge’s potential energy, and that potential energy gets turned into kinetic energy as the charge goes through the resistor— and then the kinetic energy ends up transferred to atoms in the resistor and so eventually turns into heat (which could also be the case for the ball if the ball hits the ground and dissipates its kinetic energy).

How exactly can you go from conservation of energy to KVL, a law of voltages?

See above question for how to think about energy conservation for the Loop Rule. Voltage is energy per charge. Energy conservation guarantees that the energy given to a charge by the battery must be the same amount as dissipated by the resistor. A charge going in a full loop must end up at the same potential it started with, so the sum of the voltage differences around the loop must be zero.

Does Kirchoff's first law also describe the conservation of thermal energy? i.e. is the given heat off by the resistor equal to the power generated by the battery?

Yes, basically. See above questions also.

Is an entire circuit an interior loop?

Yes, you can consider it an interior loop, if it's not subdivided. In practice, for Kirchoff's Law problems, you can consider any loop.

Does the definition of "interior loop" matter for calculating?

In practice, just select loops such that you include all the relevant circuit elements, in order to get enough equations to solve for the needed unknowns. You may be able to write more loops than needed; additional loops are not necessarily wrong, but won't add more information.

Is there ever a case where the branch method works and the loop doesn't, or vice versa? Or is it just a matter of preference for using them?

The "branch current" and "loop current" methods of applying Kirchoff's Laws are mathematically equivalent. So it's basically a matter of preference. I like the branch method better as you get the physical quantities directly out of it. But sometimes the loop current method can be algebraically easier.