Analysis steps for DC circuits (for AP Physics 1)

Neatly and graphically represent situation(s)

1. Carefully read the problem three times.
2. Draw **large** circuit **diagram**, expressing circuit in terms of ideal batteries (pure emfs), ideal wires, and ideal resistors. A battery that has an internal resistance can be drawn as a pure emf in series with a pure resistance.
3. **Label** all **givens** (numerical values, e.g. $2\ \mathrm{A}$ and $3.75\ \Omega$).
4. Visibly **indicate quantities to be found** (e.g. dashed boxes).

Graphically represent quantities and their relationships

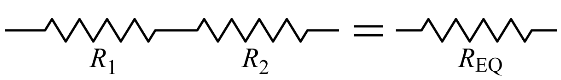
5. Indicate all **equipotential sets** using **highlighter** pens.
   (a) Ideal wire drops no potential.
   (b) You can choose to identify a reference potential position ("ground") labeled "$0\ \mathrm{V}$."
   (c) Label any known potentials repeatedly at various locations in each equipotential set.
6. Indicate **currents** with **labeled arrows**.
7. Indicate accumulated **"net"** ("excess") **charge** using icons of $+$**s and/or** $-$**s**.

Identify relevant allowed starting point (in)equations and **Analyze**

(Use whatever combination of steps 6-11 is necessary for solving a problem).

8. For an **emf**, solve for the emf $\mathcal{E}$, the potential V_1 on one side of the emf, or the potential V_2 on the other side of the emf by applying $\mathcal{E} = |V_1 - V_2|$.
9. **Collapse** series/parallel **resistor combinations** and **compute** corresponding R_{EQ}s. **Redraw** labeled circuit to **illustrate each incremental simplification** made.

Resistors in series

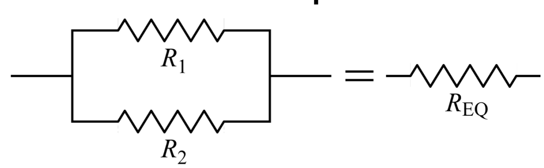


$$R_1 + R_2 + \cdots = R_{\mathrm{EQ}}$$

$$I_1 = I_2 = \cdots = I_{\mathrm{EQ}}$$

ΔV_{EQ} divides so that $\Delta V_i \propto R_i$

Resistors in parallel



$$\frac{1}{R_1} + \frac{1}{R_2} + \cdots = \frac{1}{R_{\mathrm{EQ}}}$$

I_{EQ} divides so that $I_i \propto \frac{1}{R_i}$

$$\Delta V_1 = \Delta V_2 = \cdots = \Delta V_{\mathrm{EQ}}$$

10. Solve for a quantity for a resistor using $|I| = \frac{|\Delta V_{\mathrm{R}}|}{R}$ (current flows toward lower V).
11. Recognize that **current** through a circuit element is **equal** to current through any other circuit element with which it is connected **in series**.
12. **Junction rule:** Deduce current in a branch connected to a junction by considering the known currents in the other branches connected to the same junction.

Only when preceding steps fail to provide enough information to obviously solve the problem, use the following technique to set up a system of equations.

13. Explicitly **write out Kirchoff's loop and junction rules** with only the remaining unknown quantities represented using algebraic variables (all other quantities "plugged in"). Alternatively, apply **nodal analysis** or **mesh analysis**. Solve using tedious **algebraic methods** (e.g. **matrix** methods if necessary).

Communicate