16: Electric Circuits

Key Physics Terms

- **Charge**: A fundamental intrinsic property of matter that gives rise to the attractions and repulsions between electrons and protons.
- **Electron**: A small, light negative particle. Electrons orbit around the nucleus of the atom.
- **Current**: Electrical charge flow past a given point per unit of time.
- **Ohm's Law**: Basic law that describe current electricity; Voltage equals current times resistance.
- **Electric Potential**: The ratio of electric potential energy to electric charge at a particular spot in an electric field. Measured in Volts.
- **Electric Potential Difference:** The work done to move a 1 Coulomb charge between two points in an electric field. Measured in Volts and sometimes called **Voltage.**
- **Resistor**: A device used to control or regular the amount of electric charge flowing.
- **Electromotive Force**: The potential difference when nothing is connected to the power supply.
- **Series Circuit**: A circuit where the components form one continuous loop. The current is constant throughout.
- **Parallel Circuit**: A circuit where each component is connected to form its own separate independent branch. The voltage is constant throughout.
- **Internal Resistance**: Resistance from the processes inside a voltage source; resistance due to the battery itself.
- **Kirchhoff's Laws**: Two laws, the junction and loop rule, that help describe circuits with multiple loops or voltage sources.
- **Junction Rule**: A restatement of conservation of charge; the current going into a junction must equal the current going out of the junction.
- **Loop Rule**: A restatement of conservation of energy; the sum of all voltages in the elements of a loop is zero.
- **Direct Current**: Electrical current that flows in only one direction.
- **Alternating Current**: Electrical current that oscillates forward and backwards.
- **Fuse**: A safety device designed to melt and disconnect a circuit after a predetermined amount of current is exceeded.
- **Circuit Breaker**: Safety device similar to a fuse, but it may be reset to reconnect the circuit.

Variables Used

- V = electric potential, potential difference, voltage
- R = resistance, electrical
- R_s = combined resistance of resistors connected in series
- R_P = combined resistance of resistors connected in parallel
- I = current
- P = power
- EMF = Electromotive force

Key Formulas and Constants

- $V=IR$ Ohm's law
- $P=IV=I^2R$
- $R_S=R_1+R_2+R_3+...$
- $R_P=1/R_1+1/R_2+1/R_3+...$
- $EMF - IR_{battery} = V_{terminal}$

Typical Key Metric Units

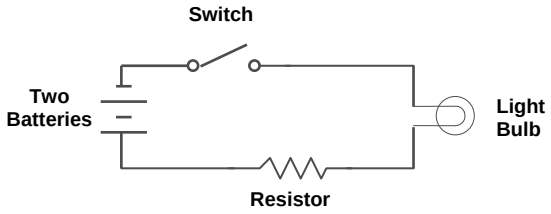
- Charge: Coulombs, C
- Current: Amperes, Amps, A
- Energy or work: Joules, J
- Electric potential: Volts, V
- Resistance: Ohms, Ω
- Power: Watts, W

Circuit Problem Solving Tips

These tips will make it easier to solve any physics problems.

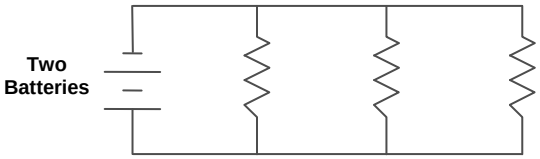
- Thoroughly read the entire problem.
- Draw a diagram if needed, especially for a circuit.
- Identify all given information.
- Identify the quantity to be found.
- Select appropriate formula(s) that incorporate what you know and what you want to find.
- Convert units if needed.
- Do any mathematical calculations carefully.

Series Circuit Diagram and Properties



1. The current is constant throughout the circuit.
2. Individual components may use varying amounts of Voltage.
3. The sum of the voltage across each component is equal to the voltage of the battery/power supply.
4. A break in the circuit interrupts the entire circuit.

Parallel Circuit Diagram and Properties



1. The current in the different branches can vary.
2. The total current of the circuit is the sum of the current in the individual branches.
3. All branches of the circuit receive the same voltage of the battery/power supply.
4. A break in one loop does not affect the others.

Typical Circuit Problem

Example: A typical 120 V household circuit has a 15 A circuit breaker in place. How many 100 W light bulbs could be connected before the circuit breaker trips?

For each individual light bulb:

P = IV
I = P/V
I = 100 W/120 V
I = 0.83 A

One bulb will surely not trip the circuit breaker. However, many will.

$$15\ A \times \frac{1\ bulb}{0.83A} = 18.07\ bulbs$$

This means that the 18th bulb will just put the circuit breaker past its limit, thus automatically shutting off the circuit. Incidentally, all of these bulbs would be connected in parallel.

How to Use This Cheat Sheet: These are the keys related to this topic. Try to read through it carefully twice then write it out on a blank sheet of paper. Review it again before the exams.

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