

Electricity

Fairlight Tuition

Sevens

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Tutorials

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Electricity 1 [Current, Voltage & Power]

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1. **Charge** (Q) coulombs [C]
2. **Current** (I) amperes [A] + direction
3. **Current definition:** The rate of flow of charge (electrons in a solid, electrons and positive ions in an electrolyte).
$$I = \frac{\Delta Q}{\Delta t}$$
4. **Potential Difference** (V) volts [V]
5. **Potential difference definition:** The work done per unit charge transferred between two points in a circuit.
$$V = \frac{W}{Q}$$
6. **Power** (P) watts [W]
7. **Power definition:** The rate at which work is done.
$$P = \frac{VQ}{\Delta t} \quad [=IV] \quad [=I^2R] \quad \left[= \frac{V^2}{R} \right]$$

Electricity 2 [Resistance]

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1. **Resistance** (R) ohms [Ω]
2. **Ohm's Law:** The potential difference across a component is directly proportional to the current through it, provided the resistance remains constant (i.e. $V \propto I$ ∴ $V = RI$).
3. **Resistivity** (ρ) ohm-metres [Ωm]
4. **Resistivity equation:**
$$\rho = \frac{RA}{l}$$
5. **Resistors in series:**
$$\sum R_s = R_1 + R_2 + R_3 \dots$$
6. **Resistors in parallel:**
$$\frac{1}{\sum R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \dots$$
7. **Superconductors:** Materials with no electrical resistance (at and below the *critical temperature*) and therefore no power losses (as $P = I^2R$). Used in high-power electromagnets and cables (e.g. MRI scanners / particle accelerators / mag-lev trains).

Electricity 3 [Thermistors & LDRs]

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1. **Drifting delocalised** electrons collide with the atoms of the component, doing work on them.
2. **These atoms** therefore vibrate with a greater amplitude, increasing the temperature of the component.
3. **The increased** vibrational amplitude of the atoms also increases the probability (and hence rate) of further collisions, reducing the drift velocity of the electrons.
4. **Increasing the pd** across a component that is increasing in temperature therefore produces a disproportionately *smaller* increase in current. The resistance therefore *increases* (as $R = V/I$).
5. **Thermistors:** When the temperature of a thermal resistor increases, the greater atomic vibrational amplitude delocalises additional electrons (charge carriers), which more than compensates for their reduced drift velocity (due to collisions with atoms).
6. **Increasing the pd** across a thermistor that is increasing in temperature therefore produces a disproportionately *larger* increase in current. The resistance therefore *decreases* (as $R = V/I$).
7. **Light Dependant Resistors:** When the light intensity falling on an LDR increases, a variant of the photoelectric effect delocalises additional electrons: the resistance therefore *decreases*.

Electricity 4 [Circuits]

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1. **Kirchhoff's First Law:** The sum of the currents at a junction is zero.
2. **Components in series:** Current *must* be the same, potential difference *may* be different.
3. **Kirchhoff's Second Law:** The sum of the potential differences in a closed loop is zero.
4. **Components in parallel:** Potential difference *must* be the same, current *may* be different.
5. **Emf equation:**
$$\mathcal{E} = IR + Ir$$
 [= terminal pd + lost volts]
6. **Peak AC voltage equation:**
$$V_0 = (\sqrt{2})(V_{rms})$$
7. **Peak AC power equation:**
$$P_0 = (2)(P_{rms})$$