Electricity

Fairlight Tuition

Sevens

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Tutorials

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Electricity 1 [Current, Voltage & Power]

1. **Charge** (*Q*) coulombs [C] [scalar]

2. **Current** (*I*) amperes [A] [scalar]

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] [scalar]

5. **Potential difference definition:** The work done per unit charge transferred through part of a circuit.

$$V = \frac{W}{Q}$$

6. **Power** (*P*) watts [W] [scalar]

7. **Power definition:** The rate at which work is done.

$$P = \frac{VQ}{\Delta t} \qquad [= IV] \qquad [= I^2 R] \qquad \left[= \frac{V^2}{R} \right]$$

Electricity 2 [Resistance]

1. **Resistance** (*R*) ohms [Ω] [scalar]

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. $V \propto I \therefore V = RI$).

3. **Resistivity** (ρ) ohm-metres [Ωm]

4. **Resistivity equation:** $\rho = \frac{RA}{l}$

5. **Resistors in series:** $\Sigma R_s = R_1 + R_2 + R_3 + \ldots$

6. **Resistors in parallel:** $\Sigma R_p = \left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots \right]^{-1}$

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]

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]

1. **Kirchhoff's First Law:** The algebraic 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 directed 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:** $\in = IR + Ir$ [= terminal pd + lost volts]

6. **Peak AC voltage equation:** $V_0 = \left(\sqrt{2}\right)\left(V_{rms}\right)$

7. **Peak AC power equation:** $P_0 = \left(2\right)\left(P_{rms}\right)$