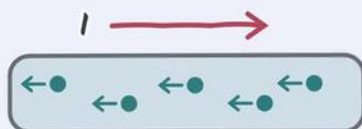


drift, Kirchhoff, and the two null instruments



Current, drift and the microscopic picture

- current $I = q/t$, and conventionally it flows in the direction a POSITIVE charge would move, which is opposite to the electron flow
- it is a scalar, despite having a direction, because currents add arithmetically at a junction and not by the parallelogram law
- free electrons move randomly at high speed; a field adds a small drift velocity v_d on top, of the order of a millimetre per second
- $I = n A e v_d$, with n the free electron density, and $v_d = eE\tau/m$ where τ is the relaxation time
- mobility $\mu = v_d / E$, and the signal travels at nearly the speed of light even though the electrons crawl, because the FIELD is established almost instantly all along the wire



electrons drift the other way

conventional I marked one way along the wire, the electrons drift the other

Ohm's law, resistance and resistivity *

Ohm's law

$$V = IR, \text{ at constant temperature}$$

resistance from geometry

$$R = \rho l / A$$

resistivity, microscopically

$$\rho = m / (n e^2 \tau)$$

current density

$$J = I/A = \sigma E, \text{ with } \sigma = 1/\rho$$

with temperature

$$R_t = R_0 (1 + \alpha t), \alpha \text{ positive for a metal}$$

power

$$P = VI = I^2 R = V^2 / R$$

resistivity depends on the MATERIAL and its temperature and not on the shape, which is why stretching a wire changes R but never ρ

