THE CHEMIST'S TOOLKIT 8 Electrical charge, current, power, and energy

Electrical charge, Q, is measured in *coulombs*, C. The elementary charge, e, the magnitude of charge carried by a single electron or proton, is approximately 1.6×10^{-19} C. The motion of charge gives rise to an **electric current**, I, measured in coulombs per second, or *amperes*, A, where $1\,\text{A} = 1\,\text{C}\,\text{s}^{-1}$. If the electric charge is that of electrons (as it is for the current in a metal), then a current of 1 A represents the flow of 6×10^{18} electrons (10 μmol e^-) per second.

When a current I flows through a potential difference $\Delta\phi$ (measured in volts, V, with $1\,\text{V} = 1\,\text{J}\,\text{C}^{-1}$), the power, P, is

$$P = I\Delta\phi \tag{8.1}$$

It follows that if a constant current flows for a period t the energy supplied is

$$E = Pt = It\Delta\phi \tag{8.2}$$

Because $1\,\text{A V s} = 1\,(\text{C}\,\text{s}^{-1})\,\text{V s} = 1\,\text{C V} = 1\,\text{J}$, the energy is obtained in joules with the current in amperes, the potential difference in volts, and the time in seconds. That energy may be supplied as either work (to drive a motor) or as heat (through a 'heater'). In the latter case

$$q = It\Delta\phi \tag{8.3}$$