THE CHEMIST'S TOOLKIT 29 Electrostatics

A charge Q_1 (units: coulomb, C) gives rise to a Coulomb **potential** ϕ (units: volt, V) , as explained in *The chemist's toolkit 6*. The potential energy (units: joule, J, with 1 J = 1 V C) of a second charge Q in that potential is

$$E_p = -Q\phi \tag{29.1}$$

In one dimension, the **electric field strength** (units: volt per metre, V m^{-1}), $\mathcal{E}$, is the negative of the gradient of the electric potential ϕ:

$$\mathcal{E} = -\frac{d\phi}{dx} \quad \text{Electric field strength} \tag{29.2}$$

In three dimensions the electric field is a vector, and

$$\boldsymbol{\mathcal{E}} = -\nabla\phi \tag{29.3}$$

The electric field between two plane parallel plates separated by a distance l, and between which there is a potential difference $\Delta\phi$, is uniform and given by

$$\mathcal{E} = -\frac{\Delta\phi}{l} \tag{29.4}$$

A charge Q experiences a force proportional to the electric field strength at its location:

$$F_{\text{electric}} = Q\mathcal{E} \tag{29.5}$$

A potential gives rise to a force only if it varies with distance.