18.48 For this problem, we are given, for NaCl, the activation energy (173,000 J/mol) and preexponential (4.0 x 10^{-4} m²/s) for the diffusion coefficient of Na⁺ and are asked to compute the mobility for a Na⁺ ion at 873 K. The mobility, μ_{Na^+} , may be computed using Equation 18.23; however, this expression also includes the diffusion coefficient D_{Na^+} , which is determined using Equation 5.8 as

$$D_{\mathrm{Na}^+} = D_0 \exp\left(-\frac{Q_d}{RT}\right)$$

=
$$(4.0 \times 10^{-4} \text{ m}^2/\text{s}) \exp \left[-\frac{173,000 \text{ J/mol}}{(8.31 \text{ J/mol}-\text{K})(873 \text{ K})}\right]$$

$$= 1.76 \text{ x } 10^{-14} \text{ m}^2/\text{s}$$

Now solving for μ_{Na^+} yields

$$\mu_{\mathrm{Na}^+} = \frac{n_{\mathrm{Na}^+} e D_{\mathrm{Na}^+}}{kT}$$

$$= \frac{(1)(1.602 \times 10^{-19} \text{ C/atom})(1.76 \times 10^{-14} \text{ m}^2/\text{s})}{(1.38 \times 10^{-23} \text{ J/atom-K})(873 \text{ K})}$$
$$= 2.34 \times 10^{-13} \text{ m}^2/\text{V-s}$$

(Note: the value of n_{Na^+} is unity, since the valence for sodium is one.)

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