18.48 For this problem, we are given, for NaCl, the activation energy (173,000 J/mol) and preexponential (4.0×10^{-4} m^2/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

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

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

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

Now solving for μ_{Na^+} yields

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

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

$$= 2.34 \times 10^{-13}\ m^2/V\text{-}s$$

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