8.6 A conductance cell consists of two electrodes, each with an area of 4.2×10^{-4} m^2, separated by 0.020 m. The resistance of the cell when filled with a 6.3×10^{-4} M KNO_3 solution is 26.7 Ω. What is the molar conductivity of the solution?

8.7 Referring to Figure 8.4, explain why the slope of conductance versus volume of NaOH added rises right at the start if the acid employed in the titration is weak.

Solubility

8.8 Calculate the solubility of $BaSO_4$ (in g L^{-1}) in **(a)** water and **(b)** a 6.5×10^{-5} M $MgSO_4$ solution. The solubility product of $BaSO_4$ is 1.1×10^{-10}. Assume ideal behavior.

8.9 The thermodynamic solubility product of AgCl is 1.6×10^{-10}. What is $[Ag^+]$ in **(a)** a 0.020 M KNO_3 solution and **(b)** a 0.020 M KCl solution?

8.10 Referring to Problem 8.9, calculate the value of $\Delta G°$ for the process

$$AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$$

to yield a saturated solution at 298 K. (*Hint:* Use the well-known equation $\Delta G° = -RT \ln K$.)

8.11 The apparent solubility products of CdS and CaF_2 at 25 °C are 3.8×10^{-29} and 4.0×10^{-11}, respectively. Calculate the solubility (g/100 g of solution) of these compounds.

8.12 Oxalic acid, $(COOH)_2$, is a poisonous compound present in many plants and vegetables, including spinach. Calcium oxalate is only slightly soluble in water ($K_{sp} = 3.0 \times 10^{-9}$ at 25 °C) and its ingestion can result in kidney stones. Calculate **(a)** the apparent and thermodynamic solubility of calcium oxalate in water, and **(b)** the concentrations of calcium and oxalate ions in a 0.010 M $Ca(NO_3)_2$ solution. Assume ideal behavior in **(b)**.

Ionic Activity

8.13 Express the mean activity, mean activity coefficient, and mean molality in terms of the individual ionic quantities ($a_+, a_-, \gamma_+, \gamma_-, m_+$, and m_-) for the following electrolytes: KI, $SrSO_4$, $CaCl_2$, Li_2CO_3, $K_3Fe(CN)_6$, and $K_4Fe(CN)_6$.

8.14 Calculate the ionic strength and the mean activity coefficient for the following solutions at 298 K: **(a)** 0.10 m NaCl, **(b)** 0.010 m $MgCl_2$, and **(c)** 0.10 m $K_4Fe(CN)_6$.

8.15 The mean activity coefficient of a 0.010 m H_2SO_4 solution is 0.544. What is its mean ionic activity?

8.16 A 0.20 m $Mg(NO_3)_2$ solution has a mean ionic activity coefficient of 0.13 at 25 °C. Calculate the mean molality, the mean ionic activity, and the activity of the compound.

Debye–Hückel Limiting Law

8.17 The Debye–Hückel limiting law is more reliable for 1 : 1 electrolytes than for 2 : 2 electrolytes. Explain.

8.18 In theory, the size of the ionic atmosphere is $1/\kappa$, called the Debye radius, and κ is given by

$$\kappa = \left(\frac{e^2 N_A}{\varepsilon_0 \varepsilon k_B T}\right)^{1/2} \sqrt{I}$$

where e is the electronic charge, N_A Avogadro's constant, ε_0 the permittivity of vacuum (8.854×10^{-12} C^2 N^{-1} m^{-2}), ε the dielectric constant of the solvent, k_B the Boltzmann constant, T the absolute temperature, and I the ionic strength (see the physical chemistry texts listed in Chapter 1). Calculate the Debye radius in a 0.010 m aqueous Na_2SO_4 solution at 25 °C.

8.19 Explain why it is preferable to take the geometric mean rather than the arithmetic mean when defining mean activity, mean molality, and mean activity coefficient.