Sample Exercise 13.3 Converting Units of Concentration

(a) A solution is made by dissolving 13.5 g of glucose ($C_6H_{12}O_6$) in 0.100 kg of water. What is the mass percentage of solute in this solution? (b) A 2.5-g sample of groundwater was found to contain 5.4 μg of Zn^{2+}. What is the concentration of Zn^{2+} in parts per million?

Solution

(a)Analyze

13.5g solute   0.100 kg solvent

Plan

$$\text{mass} \% = \frac{\text{mass solute}}{\text{mass soln}} \times 100\%$$

Solve

$$\text{mass} \% = \frac{13.5g}{(13.5 + 100.)g} \times 100\% = 11.9\%$$

Solutions

Sample Exercise 13.3 Converting Units of Concentration

Continued

(b)

Plan

5.4 μg solute   2.5g solvent

Solve

$$ppm = \frac{\text{mass solute}}{\text{mass soln}} \times 10^6 \ ppm$$

$$= \frac{5.4 \times 10^{-6} \ g}{2.5(+ 5.4 \times 10^{-6})g} \times 10^6 = 2.2 \ ppm$$

Practice Exercise
(a) Calculate the mass percentage of NaCl in a solution containing 1.50 g of NaCl in 50.0 g of water.
(b) A commercial bleaching solution contains 3.62 mass % sodium hypochlorite, NaOCl. What is the mass of NaOCl in a bottle containing 2.50 kg of bleaching solution?
Answer: (a) 2.91%, (b) 90.5 g of NaOCl

Solutions

Sample Exercise 13.4 Calculation of Molality

A solution is made by dissolving 4.35 g glucose ($C_6H_{12}O_6$) in 25.0 mL of water at 25 °C. Calculate the molality of glucose in the solution. Water has a density of 1.00 g/mL.

Solution

Analyze

4.35 g solute   25.0 mL water

Plan

$$m = \frac{mols\ solute}{mass\ solvent\ (kg)}$$

$MW_{C_6H_{12}O_6} = 180.2\ g/m\ell$

Solve

$$= \frac{\left(4.35\ g \times \frac{1\ mol}{180.2\ g}\right)}{(25.0\ mL \cdot 1.00\ g/mL) \times \frac{1\ kg}{10^3\ g}} = \frac{0.024\ mol}{0.025\ kg} = 0.964\ m$$

Practice Exercise

What is the molality of a solution made by dissolving 36.5 g of naphthalene ($C_{10}H_8$) in 425 g of toluene (C_7H_8)?
Answers: 0.670 m

Solutions

Sample Exercise 13.5 Calculation of Mole Fraction and Molality

An aqueous solution of hydrochloric acid contains 36% HCl by mass. **(a)** Calculate the mole fraction of HCl in the solution. **(b)** Calculate the molality of HCl in the solution.

Solution

Analyze.

36% (wt/wt) HCl

Plan

36 g HCl per 100 g sol^n. ∴ 64 g H_2O

Solve (a)

$$X_{HCl} = \frac{mol\ HCl}{total\ \#mols} = \frac{\left(36\ g \times \frac{1\ mol}{36.5\ g}\right)}{\left(36 \times \frac{1\ mol}{36.5\ g}\right) + \left(64\ g \times \frac{1\ mol}{18\ g}\right)} = \frac{0.99}{4.6}$$

$$= 0.22$$

Solutions

$$m = \frac{0.99}{0.064\ kg} = 15\ m$$