Solutions Problems

KEY

Density of water: $\frac{750\,mL}{1} \times \frac{1\,g}{mL} \times \frac{1\,Kg}{1000\,g} = .750\,Kg$

1) Calculate the molality of 25.0 grams of KBr dissolved in 750.0 mL pure water.

molality = $\frac{\text{mol solute}}{\text{Kg solvent}}$ $\frac{25.0\,g\,KBr}{1} \times \frac{1\,mol\,KBr}{119\,g\,KBr} = .21\,mol$ $\frac{.21\,mol}{.750\,Kg} = .28\,m$

2) 80.0 grams of glucose ($C_6H_{12}O_6$, mol. wt = 180. g/mol) is dissolved in1.00 kg of water. Calculate the molality.

$\frac{80\,g\,C_6H_{12}O_6}{1} \times \frac{1\,mol\,C_6H_{12}O_6}{180\,g} = \frac{.444\,mol}{1\,Kg} = .444\,m$

3) Calcuate the molality when 75.0 grams of $MgCl_2$ is dissolved in 500.0 g of solvent.

$\frac{75\,g\,MgCl_2}{1} \times \frac{1\,mol\,MgCl_2}{95\,g\,MgCl_2} = \frac{.7895\,mol}{.500\,Kg} = 1.58\,m$

Density = 1 Kg/L

4) 100.0 grams of sucrose ($C_{12}H_{22}O_{11}$, mol. wt. = 342.3 g/mol) is dissolved in 1.50 L of water. What is the molality?

$\frac{100.0\,g\,C_{12}H_{22}O_{11}}{1} \times \frac{1\,mol\,C_{12}H_{22}O_{11}}{342.3\,g} = \frac{.292\,mol\,C_{12}H_{22}O_{11}}{1.5\,Kg} = .195\,m$

5) 49.8 grams of KI is dissolved in 1.00 kg of solvent. What is the molality?

$\frac{49.8\,g\,KI}{1} \times \frac{1\,mol\,KI}{166\,g\,KI} = \frac{0.3\,mol\,KI}{1\,Kg} = .3\,m$

6) What is the molality of a solution consisting of 45g of $MgCl_2$ dissolved in 620g of H_2O?

$\frac{45\,g\,MgCl_2}{1} \times \frac{1\,mol\,MgCl_2}{95\,g\,MgCl_2} = \frac{.474\,mol\,MgCl_2}{.620\,Kg\,H_2O} = .764\,m$

7) What is the mole fraction of ethanol in a solution made of 92g of C_2H_5OH and 144g of H_2O?

$\frac{92\,g\,C_2H_5OH}{1} \times \frac{1\,mol\,C_2H_5OH}{46\,g\,C_2H_5OH} = 2\,mol\,C_2H_5OH$ $\frac{144\,g\,H_2O}{1} \times \frac{1\,mol\,H_2O}{18\,g\,H_2O} = 8\,mol\,H_2O$ $\frac{2\,mol\,C_2H_5OH}{10\,mol\,Total} = .2$

8) What is the mole fraction of H_2O in question #7?

$\frac{8\,mol\,H_2O}{10\,mol\,total} = .8$

9) What is the mass percent of ethanol in question #7?

$92\,g + 144\,g = 236\,g$ $\frac{92\,g}{236\,g} = 39\%\ \text{ethanol}$

10a. How many moles of solute are contained in 343 grams of a 23% aqueous solution of $MgCr_2O_7$?

$\frac{343\,g\,of\,soln}{1} \times \frac{23\,g\,MgCr_2O_7}{100\,g\,soln} \times \frac{1\,mol\,MgCr_2O_7}{240\,g\,MgCr_2O_7} = .329\,mol\,MgCr_2O_7$

10b.How many grams of solute are contained in the solution of question 10a?

$\frac{.329\,mol\,MgCr_2O_7}{1} \times \frac{240\,g\,MgCr_2O_7}{1\,mol\,MgCr_2O_7} = 78.96\,g\,MgCr_2O_7$

10c. How many grams of water (the solvent) are contained in the solution of question 10a?

$$\frac{343\text{ g Soln}}{1} \times \frac{73\text{ g } H_2O}{100\text{ g Soln}} \times \cdots\cdots = \boxed{250.39\text{ g } H_2O}$$

264.11 g

10d. How many molecules of water are contained in the solution of question 10a?

$$\frac{250.39\text{ g } H_2O}{1} \times \frac{1\text{ mol } H_2O}{18\text{ g } H_2O} \times \frac{6.02\times10^{23}\text{ molecules } H_2O}{1\text{ mol } H_2O} = \boxed{8.37\times10^{24}\text{ molecules } H_2O}$$

8.83×10^{24}

8.7×10^{24}

10e. How many Cr atoms are contained in the solution of question 10a?

$$\frac{.329\text{ mol } MgCr_2O_7}{1} \times \frac{6.02\times10^{23}\text{ molecules } MgCr_2O_7}{1\text{ mol } MgCr_2O_7} \times \frac{2\text{ Cr atoms}}{1\text{ molecule } MgCr_2O_7} = \boxed{3.96\times10^{23}\text{ Cr atoms}}$$

11a. The density of a 0.13% solution of NaCl is 2.16 g/mL. What mass of NaCl would be required to prepare 45L of this solution?

.13/100

g NaCl ?

$$\frac{45\text{L Soln}}{1} \times \frac{.13\text{L NaCl}}{100\text{L Soln}} \times \frac{1000\text{ mL NaCl}}{1\text{L NaCl}} \times \frac{2.16\text{ g NaCl}}{1\text{ mL NaCl}} = \boxed{126.36\text{ g NaCl}}$$

11b. How many molecules of solute are contained in the solution of question 11a?

$$\frac{126.36\text{ g NaCl}}{1} \times \frac{1\text{ mol NaCl}}{58.5\text{ g NaCl}} \times \frac{6.02\times10^{23}\text{ molecules NaCl}}{1\text{ mol NaCl}} = \boxed{1.3\times10^{24}\text{ molecules NaCl}}$$

12a. Specific gravity of a 33% $(NH_4)_2SO_4$ solution is 1.1. What mass of $(NH_4)_2SO_4$ would be required to prepare 201mL of this solution?

Specific gravity = $\frac{\text{density of solute}}{\text{density of water}}$

$1.1 = \frac{\text{density of } (NH_4)_2SO_4}{1\text{ g/mL}}$

$(1\text{ g/mL})1.1 = \frac{\text{density of } (NH_4)_2SO_4}{1\text{ g/mL}}(1\text{ g/mL})$

$1.1\text{ g/mL} = \text{density of } (NH_4)_2SO_4$

$\frac{1.1\text{ g}}{1\text{ mL}}\ (NH_4)_2SO_4$

$\frac{1.1\text{ g soln}}{1\text{ mL}} \times 201\text{ mL}$

$\frac{221.1\text{ g soln}}{1} \times \frac{33\text{ g } (NH_4)_2SO_4}{100\text{ g soln}}$

$\boxed{72.963\text{ g } (NH_4)_2SO_4}$

12b. How many moles of solute are contained in the solution of question 12a?

$$\frac{72.963\text{ g } (NH_4)_2SO_4}{1} \times \frac{1\text{ mol } (NH_4)_2SO_4}{132\text{ g } (NH_4)_2SO_4} = \boxed{.553\text{ mol } (NH_4)_2SO_4}$$

13. A solution contains 50 ppm of sulfate (SO_4^{2-}). What is the concentration of sulfur (S), in ppm?

See me I didn't finish

$$\frac{50\text{ parts } SO_4^{2-}\ (\text{ions})}{1{,}000{,}000} \times \frac{1\text{ part S}}{\text{parts ions}}$$

$$\frac{50\text{ parts } SO_4^{2-}}{1{,}000{,}000} \times \frac{\text{atoms S}}{1}$$

what % by mass is SO_4^{2-}? $\frac{32}{96} = .333$

$.333 \times 50\text{ ppm} = 16.7$

Don't worry about this one.

S is 16.7 ppm

$\text{ppm} = \frac{\text{mass of solute}}{\text{mass of Soln}} \times 1{,}000{,}000$

$50\text{ ppm} = \frac{\text{mass of solute}}{\text{mass of soln}} \times 1{,}000{,}000$

$\frac{50\text{ mg } SO_4^{2-}}{1000\text{ g soln}}$