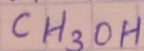


Written Assignment 2: physical Properties of Solutions

1. Increasing solubility in water



2. (a) 5.50 g of NaBr in 78.2 g of solution.

$$\% \text{ by mass} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

$$= \frac{5.5}{78.2} \times 100 = 7.03\%$$

(b) 31.0 g of NaCl in 152 g of water

$$\% \text{ by mass} = \frac{\text{Mass of solute}}{\text{Mass of solute} + \text{Mass of solvent}} \times 100$$

$$= \frac{31}{31 + 152} \times 100$$

$$= 16.94\%$$

(c) 4.5 g of toluene in 29 g of benzene.

$$\% \text{ by mass} = \frac{4.5}{4.5 + 29} \times 100$$

$$= 13.43\%$$

3. (a) 14.3 g of sucrose in 676 g of water

$$C_{12}H_{22}O_{11} \text{ Molar mass} = 12(12) + 1(22) + 16(11) = 342 \text{ g/mol}$$

$$\text{Molality} = \frac{\text{Moles of solute}}{\text{Mass of solvent}}$$

$$\text{Moles of solute} = \frac{14.3}{342} = 0.0418 \text{ mol.}$$

$$\text{Mass of solvent} = \frac{676}{1000} = 0.676 \text{ kg.}$$

$$\text{Molality} = \frac{0.0418}{0.676} = 0.0619 \text{ mol/kg.}$$

(b) 7.2 moles of ethylene glycol in 3546 g of water

$$\text{Moles of solute} = 7.2 \text{ moles}$$

$$\text{Mass of solvent} = \frac{3546}{1000} = 3.546 \text{ kg.}$$

$$\text{Molality} = \frac{7.2}{3.546} = 2.03 \text{ mol/kg.}$$

4. (a) 1.22 M sugar solution

$$\text{Number of moles of solute} = 1.22 \text{ mol.}$$

$$\text{Molar mass of } C_{12}H_{22}O_{11} = 342 \text{ g/mol}$$

$$\text{Mass of solute} = 1.22 \times 342 = 417.24 \text{ g}$$

$$\text{Mass of solution} = 1 \text{ L} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times 1.22 \text{ g/mL} = 1120 \text{ g}$$

$$\text{Mass of water} = 1120 - 417.24 = 702.76 \text{ g.}$$

$$= 0.70276 \text{ kg.}$$

$$\text{Molality} = \frac{\text{moles of solute}}{\text{Mass of water}} = \frac{1.22}{0.70276} = 1.736 \text{ m}$$

(b) 0.87 M NaOH solution

$$\text{Number of moles of solute} = 0.87 \text{ mol}$$

$$\text{Molar mass of NaOH} = 40 \text{ g/mol}$$

$$\text{Mass of solute} = 0.87 \times 40 = 34.8 \text{ g.}$$

$$\text{Mass of solution} = 1 \text{ L} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times 1.04 \text{ g/mL} = 1040 \text{ g}$$

$$\text{Mass of water} = 1040 - 34.8 = 1005.2 \text{ g}$$

$$= 1.0052 \text{ kg.}$$

$$\text{Molality} = \frac{0.87}{1.0052} = 0.865 \text{ m}$$

(C) 5.24M NaHCO_3

Number of moles of solute = 5.24 mol.

Molar mass $\text{NaHCO}_3 = 84 \text{ g/mol}$

Mass of solute = $5.24 \times 84 = 440.16 \text{ g}$

Mass of solution = $1 \text{ L} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times 1.19 \text{ g/mL} = 1190 \text{ g}$

Mass of water = $1190 - 440.16 = 749.84 \text{ g}$

$= 0.74984 \text{ kg}$

Molality = $\frac{5.24}{0.74984} = 6.988 \text{ m}$

5. Volume = $1 \text{ L} = 1000 \text{ mL}$
Density = 0.798 g/mL

Mass percentage of solute = $\frac{75}{2} = 37.5\%$

Mass = Density $\times$ Volume = 0.798×1000
 $= 798 \text{ g}$

Mass Number of grams of solute = $\frac{0.375 \times 798}{100} =$

$= \frac{37.5\% \times 798}{100\%} = 299.25 \text{ g}$

6. Mass of solute = 30 g Density = 0.982 g/mL
Mass of solvent = 70 g
 NH_3 , molar mass = 17.03 g/mol

Number of moles, $\text{NH}_3 = \frac{30}{17.03} = 1.762 \text{ moles}$

Volume of solution = $\frac{\text{Mass of solute} + \text{Mass of solvent}}{\text{Density}}$

$= \frac{30 + 70}{0.982} = 101.833 \text{ mL}$

Molarity = $\frac{\text{Moles of solute}}{\text{Volume of solution}} = \frac{1.762}{101.833} \times 1000 = 17.3 \text{ M}$

Molality = $\frac{\text{Moles of solute}}{\text{Mass of solvent}} = \frac{1.762}{70} \times 1000 = 25.17 \text{ m}$

7. Density = 1.42 g/mL

Volume = 30 mL

Mass = Density $\times$ Volume

$= 1.42 \times 30 = 42.6 \text{ g}$

70% nitric acid = $42.6 \text{ g} \times 0.7 = 29.82 \text{ g}$

HNO_3 molar mass = 63.01 g/mol

HNO_3 , number of moles = $\frac{\text{mass}}{\text{molar mass}} = \frac{29.82}{63.01} = 0.4733 \text{ mol}$

Concentration = $\frac{0.4733}{0.03} = 15.78 \text{ M}$

$M_1 V_1 = M_2 V_2$

$M_1 = 15.78 \text{ M}$, $V_1 = 30 \text{ mL}$, $V_2 = 255 \text{ mL}$

$15.78 \times 30 = M_2 \times 255$

$M_2 = \frac{15.78 \times 30}{255} = 1.86 \text{ M}$

8 (a) Solubility = $\frac{3.2 \text{ g}}{9.1 \text{ g}} \times 100 \text{ g} = 35.165 \text{ g/100 g of water}$

(b) Quantity of water

$= \frac{25}{35.165} \times 100 = 71.1 \text{ g}$

(c) Percentage of the salt dissolves

$= 0.35165 \times 15 = 5.275 \text{ g of salt dissolves}$

% of the salt dissolves = $\frac{5.275}{100} \times 100$

9. ~~Boiling the water increases~~ = 52.75%

9. Boiling the water increases the temperature. The supply of oxygen in water decreases due to lower solubility of the boiled water. Therefore, there will be no oxygen in the water for the gold fish to survive.

$$10. \Delta T_b = K_b \times m$$

$$2.53 \times 2.47 = T_s - 80.1$$

$$6.25 = T_s - 80.1$$

$$T_s = 80.1 + 6.25$$

$$= 86.35^\circ\text{C}$$

$$K_f \times m = \Delta T_f$$

$$5.12 \times 2.47 = 5.5 - T_s$$

$$12.65 = 5.5 - T_s$$

$$T_s = 5.5 - 12.65$$

$$= -7.15^\circ\text{C}$$

$$11. \text{C} : \frac{80.78}{12} = 6.73 \quad \text{H} : \frac{13.56}{1} = 13.56 \quad \text{O} : \frac{5.66}{16} = 0.354$$

Divide all through by the lower number.

$$\text{C} : \frac{6.73}{0.354} = 19$$

$$\text{H} : \frac{13.56}{0.354} = 38$$

$$\text{O} : \frac{0.354}{0.354} = 1$$

Empirical Formula: $\text{C}_{19}\text{H}_{38}\text{O}$

$$\Delta T_f = m \times K_f$$

$$= \frac{1}{5.5 - 3.37} \times \frac{1}{0.0085} \times 5.12$$

$$= 282.79 \text{ g/mol}$$

12

$$\Delta T_f = 0 - (-20) = 20^\circ\text{C}$$

$$m = \frac{\Delta T_f}{K_f} = \frac{20}{1.86} = 10.75 \text{ m}$$

$$\text{Moles of solute} = 10.75 \times 6.5 = 69.875 \text{ mol}$$

$$\text{Molar mass} = 62.08 \text{ g/mol}$$

$$\begin{aligned}\text{Mass of solute} &= 69.875 \times 62.08 \\ &= 4337.89\end{aligned}$$

$$\begin{aligned}\text{Volume of ethylene glycol} &= \frac{\text{Mass}}{\text{Density}} \\ &= \frac{4337.8}{1.11} = 3907.93 \text{ mL} \\ &= 3.90793 \text{ L}\end{aligned}$$

$$\begin{aligned}\Delta T_b &= K_b m = \frac{0.52^\circ\text{C}}{m} \times 10.75m \\ &= 5.59^\circ\text{C}\end{aligned}$$

$$\Delta T_b = T_b - T$$

$$T_b - 100 = 5.59$$

$$T_b = 105.59^\circ\text{C}$$

13.

$$T = 273 + 22 = 295 \text{ K}$$

$$M = 1.36 \text{ M}$$

$$\begin{aligned}\text{Osmotic Pressure} &= MRT \\ &= 1.36 \times 0.0821 \times 295 \\ &= 32.94 \text{ atm}\end{aligned}$$

14.

$$\pi = 1.43$$

$$T = 273 + 27 = 300 \text{ K}$$

$$\pi = MRT$$

$$1.43 = M \times 0.0821 \times 300$$

$$M = 0.0581 \text{ M}$$

$$\begin{aligned}\text{Moles of solute} &= \text{Volume} \times \text{Molarity} \\ &= 0.3 \times 0.0581 \\ &= 0.01742 \text{ mol}\end{aligned}$$

$$\begin{aligned}\text{Molecular mass} &= \frac{0.01742 \times 7.48}{0.01742} \\ &= 429.446 \text{ g/mol}\end{aligned}$$

$$\text{Carbon: } 0.418 \times 429.446 = 179.51 \text{ g}$$

$$\text{Number of moles} = \frac{179.51}{12} = 15$$

$$\text{Hydrogen: } 0.047 \times 429.446 = 20.18 \text{ g}$$

$$\text{Number of moles} = \frac{20.18}{1} = 20$$

$$\text{Oxygen: } 0.373 \times 429.446 = 160.18 \text{ g}$$

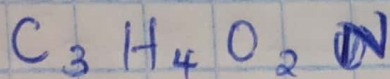
$$\text{Number of moles} = \frac{160.18}{16} = 10$$

$$\text{Nitrogen: } 0.163 \times 429.446 = 70 \text{ g}$$

$$\text{Number of moles} = \frac{70}{14} = 5$$

$$\text{C: } \frac{15}{5}, \text{ H: } \frac{20}{5}, \text{ O: } \frac{10}{5}, \text{ N: } \frac{5}{5}$$

$$3 \quad 4 \quad 2 \quad 1$$



- 15.
- 0.15m $\text{C}_6\text{H}_{12}\text{O}_6$
 - 0.15m CH_3COOH
 - 0.1m Na_3PO_4
 - 0.2m MgCl_2
 - 0.35m NaCl