

Name: Solutions

Student #: _____

CHEM 1101 Assignment: Solutions, Concentrations, Reactions, and Stoichiometry

Submit hand-written solutions on this sheet. Show your work.

1. You have a 1.80 M sodium phosphate solution, whose density is 1.13 g/mL. Calculate its (a) mol fraction, (b) mass %, (c) molality, (d) normal freezing point, and (e) normal boiling point. Show your steps. Continue work onto the next page, if needed.

Let's assume a 1L volume:

$$\text{mass sol}^n = 1000 \text{ mL} \times \frac{1.13 \text{ g}}{1 \text{ mL}} = 1130 \text{ g}$$

$$\text{mass salt} = 1.80 \text{ mol} \times \frac{163.94 \text{ g}}{1 \text{ mol}} = 295.092 \text{ g}$$

$$\therefore \text{mass H}_2\text{O} = \text{mass sol}^n - \text{mass salt} = 1130 \text{ g} - 295.092 \text{ g} = 834.908 \text{ g}$$

$$\# \text{ mol H}_2\text{O} = 834.908 \text{ g} \times \frac{1 \text{ mol}}{18.0148 \text{ g}} = 46.3456 \text{ mol H}_2\text{O}$$

$$\text{(a) mol fraction} = \frac{1.80 \text{ mol}}{(1.80 \text{ mol} + 46.3456 \text{ mol})} = 0.03738 = \underline{0.037 \text{ (or } 3.7\%)}$$

$$\text{(b) mass \%} = \frac{295.092 \text{ g}}{1130 \text{ g}} \times 100\% = \underline{26.1\%}$$

$$\text{(c) molality, } m = \frac{\# \text{ mol Na}_3\text{PO}_4}{\# \text{ kg H}_2\text{O}} = \frac{1.80 \text{ mol}}{0.834908 \text{ kg}} = 2.1559 \text{ m} = \underline{2.2 \text{ m}}$$

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1 (cont'd)

d) normal freezing point :

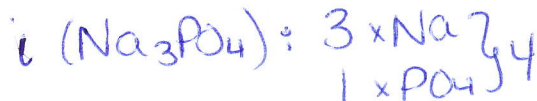
$$\begin{aligned}\Delta T_f &= K_f m i \\ &= (1.86^\circ\text{C}/m)(2.1559m)(4) \\ &= 16.0398^\circ\text{C}\end{aligned}$$

$$\therefore T_f = \underbrace{0^\circ\text{C}}_{\text{exact value}} - 16.0398^\circ\text{C} = \underline{-16^\circ\text{C}}$$

e) normal boiling point :

$$\begin{aligned}\Delta T_b &= K_b m i \\ &= (0.52^\circ\text{C}/m)(2.1559m)(4) \\ &= 4.4842^\circ\text{C}\end{aligned}$$

$$\therefore T_b = \underbrace{100^\circ\text{C}}_{\text{exact value}} + 4.4842^\circ\text{C} = 104.5^\circ\text{C}$$



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2. If 850.0 g potassium chlorate is combined with 300.0 g sucrose and they react as above, determine the mass of potassium chloride that forms. (**Note that the above reaction is not balanced!**))

$$\text{KClO}_3: 850.0 \text{ g} \times \frac{1 \text{ mol}}{122.548 \text{ g}} = 6.9360577 \text{ mol KClO}_3 \text{ available}$$

$$\text{C}_{12}\text{H}_{22}\text{O}_{11}: 300.0 \text{ g} \times \frac{1 \text{ mol}}{342.2948 \text{ g}} = 0.8764375 \text{ mol C}_{12}\text{H}_{22}\text{O}_{11} \text{ available.}$$

Determine limiting reagent:

$$\text{If all KClO}_3 \text{ is reacted: } \# \text{ mol C}_{12}\text{H}_{22}\text{O}_{11} \text{ needed} = 6.9360577 \text{ mol KClO}_3 \times \frac{1 \text{ C}_{12}\text{H}_{22}\text{O}_{11}}{8 \text{ KClO}_3}$$

$$= 0.867007 \text{ mol}$$

- ∴ There is enough glucose (we actually have 0.8764375 mol).
 ∴ The limiting reagent is KClO₃.

$$n_{\text{KCl}} \text{ formed} = 6.9360577 \text{ mol KClO}_3 \times \frac{8 \text{ mol KCl}}{8 \text{ mol KClO}_3} = 6.9360577 \text{ mol KCl}$$

$$m_{\text{KCl}} = 6.9360577 \text{ mol} \times \frac{74.551 \text{ g}}{1 \text{ mol}} = 517.09 \text{ g KCl}$$

$$= \underline{\underline{517.1 \text{ g KCl}}}$$