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:

$\text{mass soln} = 1000\,\text{mL} \times \frac{1.13\,\text{g}}{1\,\text{mL}} = 1130\,\text{g}$

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

$\therefore \text{mass } H_2O = \text{mass soln} - \text{mass salt} = 1130\,\text{g} - 295.092\,\text{g} = 834.908\,\text{g}$

$\#\text{mol } H_2O = 834.908\,\text{g} \times \frac{1\,\text{mol}}{18.0148\,\text{g}} = 46.3456\,\text{mol } H_2O$

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

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

(c) molality, $m = \frac{\#\text{mol } Na_3PO_4}{\#\text{kg } H_2O} = \frac{1.80\,\text{mol}}{0.834908\,\text{kg}} = 2.1559\,m = 2.2\,m$

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1 (cont'd)

d) normal freezing point:

$i\ (Na_3PO_4)$: $3 \times Na^+$, $1 \times PO_4^{3-}$ → 4

$\Delta T_f = K_f m i$

$= (1.86\ ^\circ C/m)(2.1559\ m)(4)$

$= 16.0398\ ^\circ C$

$\therefore T_f = 0\ ^\circ C - 16.0398\ ^\circ C = -16\ ^\circ C$

(0 °C: exact value)

e) normal boiling point:

$\Delta T_b = K_b m i$

$= (0.52\ ^\circ C/m)(2.1559\ m)(4)$

$= 4.4842\ ^\circ C$

$\therefore T_b = 100\ ^\circ C + 4.4842\ ^\circ C = 104.5\ ^\circ C$

(100 °C: exact value)

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$$8\ KClO_3 + 1\ C_{12}H_{22}O_{11} \longrightarrow 8\ KCl + 12\ CO_2 + 11\ H_2O$$

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!**)

$KClO_3$: $850.0\ g \times \frac{1\ mol}{122.5489\ g} = 6.9360577\ mol\ KClO_3$ available

$C_{12}H_{22}O_{11}$: $300.0\ g \times \frac{1\ mol}{342.2948\ g} = 0.8764375\ mol\ C_{12}H_{22}O_{11}$ available.

Determine limiting reagent:

If all $KClO_3$ is reacted: $\#mol\ C_{12}H_{22}O_{11}$ needed $= 6.9360577\ mol\ KClO_3 \times \frac{1\ C_{12}H_{22}O_{11}}{8\ KClO_3}$

$= 0.8670007\ mol$

∴ There is enough glucose (we actually have 0.8764375 mol).

∴ The limiting reagent is $KClO_3$.

$n_{KCl\ formed} = 6.9360577\ mol\ KClO_3 \times \frac{8\ mol\ KCl}{8\ mol\ KClO_3} = 6.9360577\ mol\ KCl$

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

$= 517.1\ g\ KCl$