Answers to Chapter 11 Study Questions

1. sodium chlorate = $NaClO_3$

$$284 \text{ g solution} \times \frac{12.0\ g\ NaClO_3}{100\ g\ solution} \times \frac{1\ mol\ NaClO_3}{106.4\ g\ NaClO_3} = 0.320 \text{ moles}$$

2. mole fraction = $\frac{moles\ C_2H_6O_2}{total\ moles}$; moles $C_2H_6O_2$ = 120. g $\times \frac{1\ mol\ C_2H_6O_2}{62.0\ g\ C_2H_6O_2}$ = 1.94 moles

$$\text{moles } C_3H_6O = 1.20 \text{ kg} \times \frac{1000\ g}{1\ kg} \times \frac{1\ mol\ C_3H_6O}{58.0\ g\ C_3H_6O} = 20.7 \text{ moles}$$

total moles = 1.94 + 20.7 = 22.6 moles; mole fraction = $\frac{1.94\ mol\ C_2H_6O_2}{22.6\ moles}$ = 0.0857

3. $$\frac{6.90\ mol\ KOH}{1\ L\ solution} \times \frac{1\ L}{1000\ mL} \times \frac{1\ mL}{1.29\ g} \times \frac{56.1\ g\ KOH}{1\ mol\ KOH} = \frac{0.300\ g\ KOH}{g\ solution} = 30.0\%\ KOH$$

30.0% KOH = 30.0 g KOH + 70.0 g H_2O; molality = moles KOH/kg water

$$\frac{30.0\ g\ KOH}{70.0\ g\ H_2O} \times \frac{1000\ g\ H_2O}{1\ kg\ H_2O} \times \frac{1\ mol\ KOH}{56.1\ g\ KOH} = 7.64 \text{ moles KOH/kg water}$$

4. methanol = CH_3OH

molarity = $\frac{moles\ CH_3OH}{L\ solution}$; 12.8 g CH_3OH $\times \frac{1\ mol\ CH_3OH}{32.0\ g\ CH_3OH}$ = 0.400 mol CH_3OH

volume CH_3OH = 12.8 g $\times \frac{1\ mL}{0.791\ g}$ = 16.2 mL; volume water = 144 mL

total volume of solution = 16.2 mL + 144 mL = 160 mL = 0.160 L

$$\text{molarity} = \frac{0.400\ mol\ CH_3OH}{0.160\ L\ solution} = 2.50 \text{ M}$$

5. The solubility of gases decreases as temperature increases. Two everyday examples of this are: 1) that soda becomes “flat” faster at room temperature than in the refrigerator since the solubility of CO2 is lower at 25°C than at 4°C, and 2) as water is heated, well before it boils, bubbles of air appear, since the solubility of air is decreasing during heating.

6. Add a small crystal. If it dissolves, the solution was unsaturated. If it doesn't dissolve, the solution was saturated. If more than the crystal comes out of solution, then the solution was supersaturated.

7. ΔT_f = 1.86 °C x moles solute particles/kg water

$\Delta T_f = 1.86\ °C \times \frac{0.11\ moles}{0.055\ kg\ H_2O} = 3.72°C$; $T_f = 0 - \Delta T_f = 0 - 3.72°C = -3.72°C$

8. $\Delta T_f = 1.86\ °C \times$ moles solute particles/kg water ; calcium chloride = $CaCl_2$

moles particles = $27.8\ g\ CaCl_2 \times \frac{1\ mol\ CaCl_2}{111\ g\ CaCl_2} \times \frac{3\ mol\ ions}{1\ mol\ CaCl_2} = 0.751$ mol particles

$\Delta T_f = 1.86\ °C \times \frac{0.751\ mol\ particles}{0.250\ kg\ H_2O} = 5.59°C$; $T_f = -5.59°C$

($CaCl_2$ is an electrolyte and it is important to remember that there are 3 moles of ions per mole of $CaCl_2$. The freezing point is three times lower than it would be for a nonelectrolyte.)

9. molar mass = mass/moles; mass = 80.0 g; find moles

moles = $\frac{\Delta T_f}{1.86} x\ kg\ H_2O = \frac{4.65^\circ C}{1.86} x\ 0.200 = 0.500$ moles

molar mass = 80.0 g/0.500 moles = 160. g/mole

10. From Table 11.5, for benzene: $K_b = 2.53°C/m$ and $T_b = 80.1°C$.

$\Delta T_b = 2.53°C/m \times \frac{0.500\ mol}{0.200\ kg} = 6.32°C$; $T_b = 80.1°C + 6.32°C = 86.4°C$

11. molar mass = mass/moles; mass = 45.0 g; find moles; $\Delta T_b = 90.2°C - 80.1°C = 10.1°C$

moles = $\frac{\Delta T_f}{2.53} x\ kg\ benzene = \frac{10.1^\circ C}{2.53} x\ 0.0750 = 0.300$ moles

molar mass = 45.0 g/0.300 moles = 150. g/mole