Answers to Chapter 15 Study Questions

1. mass percent = $\frac{mass\ KMnO_4}{mass\ solution} x\ 100\%$;

   mass $KMnO_4$ = 1.00 mole = 158 g; mass solution = 158 g $KMnO_4$ + 158 g H_2O = 316 g

   mass percent = $\frac{158\ g\ KMnO_4}{316\ g\ solution}$ = 50.0 %

2. 335 g solution $x\ \frac{22.0\ g\ KMnO_4}{100\ g\ solution} x\ \frac{1\ mol\ KMnO_4}{158\ g\ KMnO_4}$ = 0.466 moles

3. 275 mL solution x $\frac{0.500\ mol\ NaCl}{1000\ mL\ solution}$ = 0.138 moles

4. 250 mL solution x $\frac{2.00\ mol\ NaCl}{1000\ mL\ solution} x\ \frac{58.5\ g\ NaCl}{1\ mol\ NaCl}$ = 29.2 g

5. V_1 x M_1 = V_2 x M_2; V_1 x 2.00 M = 125 mL x 0.350 M

   V_1 = 125 mL x 0.350 M/2.00 M = 21.9 mL

6. molarity = $\frac{moles\ solute}{L\ solution}$; $\frac{90.0\ g\ glucose}{200\ mL\ solution} x \frac{1000\ mL}{1\ liter} x \frac{1\ mol\ glucose}{180\ g\ glucose}$ = 2.50 M

7. $\frac{24.0\ g\ sucrose}{100\ g\ solution} x \frac{1\ mol\ sucrose}{342\ g\ sucrose} x \frac{1.10\ g\ solution}{1\ cm^3\ solution} x \frac{1000\ cm^3\ solution}{1\ L\ solution}$ = 0.772 M

8. a) $CaCl_2(aq)$ + 2 $AgNO_3(aq)$ → 2 $AgCl(s)$ + $Ca(NO_3)_2(aq)$

   b) 1.72 g AgCl x $\frac{1\ mol\ AgCl}{143.3\ g\ AgCl} x \frac{1\ mol\ CaCl_2}{2\ mol\ AgCl} x \frac{1000\ mL\ solution}{0.250\ mol\ CaCl_2}$ = 24.0 mL

9. V_A x M_A = V_B x M_B; V_B x 0.400 M = 16.0 mL x 0.120 M

   V_B = 16.0 mL x 0.120 M/0.400 M = 4.80 mL

10. Colligative properties: vapor pressure, boiling point, freezing point.
    Not colligative properties: color, electrical conductivity, density

11. Highest boiling point = greatest number of solute particles.
    c) 1.0 M $Ca(NO_3)_2$ > d) 1.0 M $MgSO_4$ > b) 1.0 M glucose ($C_6H_{12}O_6$) > a) pure water
    3 mol particles/mol 2 mol particles/mol 1 mol particles/mol

12. a) ΔT_f = 1.86 °C x moles solute particles/kg water

    ΔT_f = 1.86 °C x $\frac{0.11\ moles}{0.055\ kg\ H_2O}$ = 3.72°C; T_f = 0 – ΔT_f = 0 – 3.72°C = –3.72°C

b) ΔT_f = 1.86 °C x moles solute particles/kg water

moles = $\frac{\Delta T_f}{1.86} x\ kg\ H_2O$ = $\frac{2.79^{O}C}{1.86} x\ 0.200$ = 0.300 moles

c) ΔT_f = 1.86 °C x moles solute particles/kg water

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

ΔT_f = 1.86 °C x $\frac{0.751\ mol\ particles}{0.250\ kg\ H_2O}$ = 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.)