Chemistry 2720 Fall 2001 Assignment 1 Solutions

1. (a) BaF_2
   (b) Na_2CO_3
   (c) H_2CO_3
   (d) $Pb(CH_3COO)_2 \cdot 10H_2O$
   (e) Na^+
   (f) NH_3
   (g) Cl_2O_7

2. (a) $CH_3OH + \frac{3}{2}O_2 \rightarrow CO_2 + 2H_2O$
   (b) $NaCl_{(s)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$
   (c) $CO_{2(g)} + H_2O_{(l)} \rightarrow H_2CO_{3(aq)}$
   (d) $2Bi^{3+}_{(aq)} + 3S^{2-}_{(aq)} \rightarrow Bi_2S_{3(s)}$

3.

$$\begin{aligned} n &= \frac{m}{M} = \frac{1.3 \times 10^{-9}\,\text{g}}{207.2\,\text{g/mol}} = 6.3 \times 10^{-12}\,\text{mol} \\ \therefore c &= \frac{n}{V} = \frac{6.3 \times 10^{-12}\,\text{mol}}{20.5 \times 10^{-3}\,\text{L}} = 3.1 \times 10^{-10}\,\text{mol/L} \equiv 0.31\,\text{nmol/L} \end{aligned}$$

4. The reaction is

$$Pb^{2+}_{(aq)} + CO^{2-}_{3(aq)} \rightarrow PbCO_{3(s)}.$$

$$\begin{aligned} n_{Pb^{2+}} &= n_{CO_3^{2-}} = (1.4\,\text{L})(0.034\,\text{mol/L}) = 0.048\,\text{mol} \\ \therefore V_{\text{solution}} &= \frac{0.048\,\text{mol}}{0.5\,\text{mol/L}} = 0.10\,\text{mol/L} \end{aligned}$$

5. I like to solve these problems using SI units. That reduces the potential confusion over units.

$$\begin{aligned}
V &= \frac{600\times 10^{-3}\,\text{L}}{1000\,\text{L}/\text{m}^3} = 6.00\times 10^{-4}\,\text{m}^3 \\
P &= (0.80\,\text{atm})(101\,325\,\text{Pa}/\text{atm}) = 8.1\times 10^{4}\,\text{Pa} \\
T &= 20 + 273.15\,\text{K} = 293\,\text{K} \\
\therefore n_{\text{N}_2} &= \frac{PV}{RT} = \frac{(8.1\times 10^4\,\text{Pa})(6.00\times 10^{-4}\,\text{m}^3)}{(8.314\,510\,\text{J}\,\text{K}^{-1}\text{mol}^{-1})(293\,\text{K})} = 0.020\,\text{mol}
\end{aligned}$$

The molar mass of $N_{2(g)}$ is 28.014 g/mol, so the mass is

$$m_{\text{N}_2} = (2\times 10^{-2}\,\text{mol})(28.014\,\text{g}/\text{mol}) = 0.6\,\text{g}.$$

6. The reaction is

$$\text{H}^+_{(\text{aq})} + \text{OH}^-_{(\text{aq})} \to \text{H}_2\text{O}_{(\text{l})}.$$

$$\begin{aligned}
\Delta\overline{H}^\circ &= \Delta\overline{H}^\circ_{f(\text{H}_2\text{O})} - \left(\Delta\overline{H}^\circ_{f(\text{H}^+)} + \Delta\overline{H}^\circ_{f(\text{OH}^-)}\right) \\
&= -285.830 - [0 + (-230.015)]\ \text{kJ/mol} \\
&= -55.815\,\text{kJ/mol}
\end{aligned}$$

7. There are three parts to consider:

   (a) Heating the liquid water to 100°C.

   (b) Vaporizing the water.

   (c) Hearing the steam to the final temperature.

$$\begin{aligned}
q_a &= m\tilde{C}_P\Delta T = (1.2\,\text{g})(4.184\,\text{J}\,\text{K}^{-1}\text{g}^{-1})(80\,\text{K}) = 0.40\,\text{kJ} \\
q_b &= m\tilde{H}_{\text{vap}} = (1.2\,\text{g})(2257\,\text{J/g}) = 2.7\,\text{kJ} \\
n_{\text{steam}} &= \frac{1.2\,\text{g}}{18.02\,\text{g/mol}} = 0.067\,\text{mol} \\
q_c &= n\overline{C}_P\Delta T = (0.067\,\text{mol})(33.76\,\text{J}\,\text{K}^{-1}\text{mol}^{-1})(20\,\text{K}) = 0.045\,\text{kJ} \\
\therefore q_{\text{total}} &= q_a + q_b + q_c = 3.2\,\text{kJ}
\end{aligned}$$

8. (a) $\dfrac{d}{dx}\left(3x^3 + 2x^2 + x + 1\right) = 9x^2 + 4x + 1$

(b) $\int_4^5 \frac{dx}{x} = \ln x|_4^5 = \ln 5 - \ln 4 = \ln(5/4)$

(c)

$$\begin{aligned}
\int_1^2 \frac{2x^2+1}{x^2} dx &= \int_1^2 \left(2 + \frac{1}{x^2}\right) dx \\
&= \int_1^2 \left(2 + x^{-2}\right) dx \\
&= \left[2x - x^{-1}\right]_1^2 \\
&= \left[2(2) - \frac{1}{2}\right] - [2(1) - 1] = \frac{5}{2}.
\end{aligned}$$