Chemistry 2710 Spring 2001 Assignment 1 Solutions

1. (a) $2x - 2x^{-3} = 2\left(x - \frac{1}{x^3}\right)$

   (b) $-ke^{-kt}$

2. (a)

$$\begin{aligned}\int_{a_0}^{a(t)} \frac{dx}{x^n} &= \int_{a_0}^{a(t)} x^{-n}\,dx \\ &= \frac{1}{1-n}x^{1-n}\Big|_{a_0}^{a(t)} \\ &= \frac{1}{1-n}\left(a(t)^{1-n} - a_0^{1-n}\right)\end{aligned}$$

   (b)

$$\begin{aligned}\int_3^{15} \frac{dx}{x} &= \ln x|_3^{15} \\ &= \ln 15 - \ln 3 = \ln(15/3) = \ln 5\end{aligned}$$

3. (a) We first convert both masses to numbers:

$$\begin{aligned}n_{S_8} &= \frac{32.0\,\text{g}}{256.48\,\text{g/mol}} = 0.125\,\text{mol} \\ n_{Cl_2} &= \frac{71.0\,\text{g}}{70.906\,\text{g/mol}} = 1.00\,\text{mol}\end{aligned}$$

   To completely react $0.125\,\text{mol}$ of S_8, we would need $4(0.125\,\text{mol}) = 0.500\,\text{mol}$ of chlorine. The chlorine is therefore in excess. The number of moles of product formed is therefore $4(0.125\,\text{mol}) = 0.500\,\text{mol}$. The mass of disulfur dichloride is therefore

$$m_{S_2Cl_2} = (0.500\,\text{mol})(135.03\,\text{g/mol}) = 67.5\,\text{g}.$$

(b)

$$V = \frac{nRT}{P} = \frac{(1.00\,\text{mol})(8.314510\,\text{J K}^{-1}\text{mol}^{-1})(323.15\,\text{K})}{90\times10^3\,\text{Pa}} = 0.030\,\text{m}^3.$$

4. We must start with a balanced reaction:

$$\text{Al}_{(\text{s})} + 3\text{HF}_{(\text{g})} \rightarrow \text{AlF}_{3(\text{s})} + \frac{3}{2}\text{H}_{2(\text{g})}.$$

$$\begin{aligned}
\Delta\bar{H}^\circ &= \Delta\bar{H}^\circ_{f(\text{AlF}_3)} + \frac{3}{2}\Delta\bar{H}^\circ_{f(\text{H}_2)} - \left(\Delta\bar{H}^\circ_{f(\text{Al})} + 3\Delta\bar{H}^\circ_{f(\text{HF})}\right) \\
&= -1510.4 - 3(-273.30)\,\text{kJ/mol} = -690.5\,\text{kJ/mol}. \\
\Delta\bar{S}^\circ &= \bar{S}^\circ_{(\text{AlF}_3)} + \frac{3}{2}\bar{S}^\circ_{(\text{H}_2)} - \left(\bar{S}^\circ_{(\text{Al})} + 3\bar{S}^\circ_{(\text{HF})}\right) \\
&= 66.5 + \frac{3}{2}(130.680) - [28.30 + 3(173.779)]\,\text{J K}^{-1}\text{mol}^{-1} \\
&= -287.117\,\text{J K}^{-1}\text{mol}^{-1}.
\end{aligned}$$

5. The slope is 2.39 and the y intercept is 1.23. In other words, the line of best fit is $y = 2.39x + 1.23$.