CHEM 361A - Lecture 1 Activity

Calculus Review and Fundamental Concepts

In Class

1. You want to make a simple syrup so your pour 50 g of sucrose (table sugar - $C_{12}H_{22}O_{11}$) into 250 g/250 mL of water (H_2O). Determine
   (a) the mole fraction of sugar (0.01)
   (b) the molarity of the sugar (0.584 M)
   (c) the molality of the sugar (0.584 moles $\cdot$ kg^{-1})
   (d) When would it be worthwhile to express the concentration of a solute using molality instead of molarity?
2. The equilibrium constant for the dissociation of AgCl is $K_{sp} = 1.8 \times 10^{-10}$. Determine the $[Ag^+]$ in a
   (a) 0.020 M KNO_3 solution ($[Ag^+] = 1.34 \times 10^{-5}$ M)
   (b) 0.020 M KCl solution ($[Ag^+] = 9.0 \times 10^{-9}$ M)

Homework

1. Review of Differentiation
   (a) Here is a set of derivatives involving polynomials. Write down the most common operations that you notice from these differentials:

$$\frac{d}{dx}\left[3x^2 + 7x^4 + 2\right] = 6x + 28x^3 \qquad \frac{d}{dx}\left[2x^{-1} + 3x\right] = -2x^{-2} + 3$$

$$\frac{d}{dx}\left[\frac{3}{4x^2} + 3\ln x^2\right] = \frac{-3}{2x^3} + \frac{6}{x} \qquad \frac{d}{dx}\left[\ln x + 3\right] = \frac{1}{x}$$

   (b) What is the name of the rule that typically governs differentials of polynomials?
   (c) For what operation above does this law not apply to even if the result gives a polynomial?
   (d) Show that

$$\frac{d}{dx}\left[6x^4 + \frac{3}{x^5} + 7\ln x^2\right] = 24x^3 - \frac{15}{x^6} + \frac{14}{x}$$

2. Partial Differentiation

(a) Here is a set of partial derivatives involving polynomials. Write down the most common operations that you notice from these differentials:

$$\frac{\partial}{\partial x}\left[xy + 2x^2 + 3y\right] = y + 4x \qquad \frac{\partial}{\partial y}\left[2\ln x + 3\ln xy\right] = \frac{3}{y}$$

$$\frac{\partial}{\partial y}\left[\frac{2}{x^2 y} + 3\ln x^2\right] = \frac{-2}{x^2y^2} \qquad \frac{\partial}{\partial x}\left[\ln x + 3\right] = \frac{1}{x}$$

(b) When the partial derivative is with respect to x, how can the y variable be treated? Conversely, when the partial derivative is with respect to y, how can the x variable be treated?

(c) Show that

i.

$$\frac{\partial}{\partial x}\left[6x^3y + \frac{4y^4}{x^2} + 2\ln y^4 + 5\right] = 18x^2y - \frac{8y^4}{x^3}$$

ii.

$$\frac{\partial}{\partial y}\left[6x^3y + \frac{4y^4}{x^2} + 2\ln y^4 + 5\right] = 6x^3 + \frac{16y^3}{x^2} + \frac{8}{y}$$

3. Review of Integration

(a) Here is a set of integrals involving polynomials. How would you rewrite the law that typically governs differentials of polynomials to work with integrating polynomials?

$$\int 3x^2 + 7x^4 + 2\ dx = x^3 + \frac{7}{5}x^5 + 2x + C \qquad \int_a^b 2x^{-1} + 3x\ dx = 2\ln x + \frac{3}{2}x^2\Big|_a^b$$

$$\int_a^b \frac{3}{4x^2} + 3x^{-2}\ dx = \frac{-3}{4x} - 3x^{-1}\Big|_a^b \qquad \int \frac{2}{x} + 3x^4 + 2\ dx = 2\ln x + \frac{3}{5}x^5 + C$$

(b) For what operation does this rewritten law not apply?

(c) When would you not include a $+C$ in your answer?

(d) Solve the following expression and show that

$$\int_2^4 5x^3 + \frac{7}{x^4} + 10x^2\ dx = 486.9$$