Chem 2 AP Homework #13-1: Problems pg 575 #7-12

7 **For the reaction: 2 NO (g) + O_2 (g) → 2 NO_2 (g), if the rate of reaction of NO is 0.066 *M*/s:**

$$\text{rate}_{NO} = \frac{\Delta[NO]}{\Delta t} = \mathbf{-0.066\ M/s}$$

(a) At what rate is NO_2 being formed?

$$\text{Rate}_{NO_2} = -\frac{2\ NO_2}{2\ NO} \times \text{Rate}_{NO} = \boxed{\mathbf{0.066\ M/s = 0.066\ mol\ L^{-1}\ s^{-1}}}$$

(b) At what rate is molecular oxygen reacting?

$$\text{Rate}_{O_2} = \frac{-1\ O_2}{-2\ NO} \times \text{Rate}_{NO} = \frac{-0.066\ \text{M/s}}{2} = \boxed{\mathbf{-0.033\ M/s = -0.033\ mol\ L^{-1}\ s^{-1}}}$$

8 **For the reaction: N_2 (g) + 3 H_2 (g) → 2 NH_3 (g), consider that molecular hydrogen is reacting at 0.074 *M*/s:**

$$\text{rate}_{H_2} = \frac{\Delta[H_2]}{\Delta t} = \mathbf{-0.074\ M/s}$$

(a) What is the rate at which ammonia is being formed?

$$\text{Rate}_{NH_3} = \frac{2\ NH_3}{-3\ H_2} \times \text{Rate}_{H_2} = -\frac{2}{3}(-0.074\ \textit{M}/\text{s}) = \boxed{\mathbf{0.049\ M/s = 0.049\ mol\ L^{-1}\ s^{-1}}}$$

(b) What is the rate at which nitrogen is reacting?

$$\text{Rate}_{N_2} = \frac{-1\ N_2}{-3\ H_2} \times \text{Rate}_{H_2} = \frac{1}{3}(-0.074\ \textit{M}/\text{s}) = \boxed{\mathbf{-0.025\ M/s = -0.025\ mol\ L^{-1}\ s^{-1}}}$$

9 **Explain what is meant by the rate law of a reaction.**

The rate law is the relationship of the rate of a reaction to the rate constant (k) and the concentrations of the reactants raised to some powers. Generically, for a reaction with reactants A and B,

$$\text{rate} = k\,[A]^x[B]^y$$

Note that x and y are not necessarily the coefficients in the balanced equation and must be determined experimentally.

10 **What is meant by the order of a reaction?**

The order of a reaction is the sum of the exponents to which all reactant concentrations in the rate law are raised. For the rate law in problem 9, the reaction order is x in reactant A and y in reactant B for an overall order of $(x + y)$.

11 **What are the units for the rate constants of first-order and second-order reactions?**

Since the rate of a reaction always has the unit of M time^{-1} or mol L^{-1} time^{-1}, the units of k must be such that when multiplied by the concentrations of reactants raised to their orders, this unit is obtained.

<u>First Order</u>: In an overall 1st order reaction, M time^{-1} = k × M, so k has the unit of time^{-1}.

<u>Second Order</u>: Here, M time^{-1} = k × M^2, so k has the unit of M^{-1} time^{-1}.

12 Consider the zero-order reaction A → product

(a) A zero-order reaction does not depend on the concentrations of the reactants, so

rate = k.

(b) Since the units for rate are M s^{-1}, the rate constant will have the same units.

(c) The plot will be a straight line, constant rate, and independent of concentration [A]: