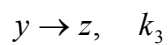
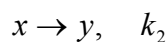
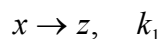


Chemistry 549
Spring 2004
Problem Set 1
Due Monday, Feb. 2

Read Chapter 1.

Do Problems 1.4, 1.8, and 1.9 in the textbook. Also do the following problems:

1. Consider the following network of first order reactions, with the indicated rate constants:



A. Derive the general result for $x(t)$, $y(t)$, $z(t)$, assuming that $x(0) = 1$, $y(0) = 0$, $z(0) = 0$.

B. Show that $z(t = \infty) = 1$

C. Show that in the limit of $k_1 t \ll 1$, $k_2 t \ll 1$, $k_3 t \ll 1$, the following results are true:

$$y(t) = k_2 t$$

$$z(t) = k_1 t$$

D. Show that in the limit of $k_1 t \gg 1$, $k_2 t \ll 1$, $k_3 t \ll 1$, the following results are true:

$$y(t) = \frac{k_2}{k_1} e^{-k_3 t}$$

$$z(t) = 1$$

E. Show that in the limit of $k_1 t \ll 1$, $k_2 t \gg 1$, $k_3 t \ll 1$, the following results are true:

$$y(t) = e^{-k_3 t}$$

$$z(t) = k_3 t$$

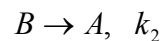
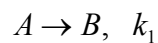
F. Show that in the limit of $k_1 t \ll 1$, $k_2 t \ll 1$, $k_3 t \gg 1$, the following results are true:

$$y(t) = \frac{k_2}{k_3} e^{-k_{12}t}$$

$$z(t) = k_{12}t$$

where $k_{12} = k_1 + k_2$.

2. Consider the first order reaction



Derive an exact expression for $A(t)$.

3. A certain molecule has an extinction coefficient of $1,000 \text{ liter mol}^{-1} \text{ cm}^{-1}$ (base e) at a wavelength of 800 nm. Suppose the molecule is in the gas phase and is irradiated with a pulsed laser having a radius of 1 mm. What must the energy of the laser pulse be to excite 10% of the molecules in its path?