

EVE 290
Introduction to Environmental Engineering
Fall 2010
Homework #10a (More Exam #1 Review)

1. During a chemical reaction, the concentration of species A was measured as a function of time. The observed concentration at various time intervals is presented below. Determine the reaction order and rate constant k .

| Time (min) | Concentration of A [mg/L] |
|------------|---------------------------|
| 0 | 200 |
| 10 | 242 |
| 20 | 111 |
| 30 | 90 |
| 40 | 77 |
| 50 | 67 |

2. If the half-life of a chemical compound is 30 days, determine the zero-order removal rate constant k .
3. If the doubling time of a chemical compound is 120 days, determine the first-order production rate constant k .
4. Three wastewater streams are combined at a food-processing facility to equalize the pH prior to biological treatment. The flow rate and pH of each of the wastewater streams is presented in the table below. Perform a mass balance on flow and the hydrogen-ion concentration $[H^+]$ so that the pH of the three combined streams may be estimated. The pH of a solution is equal to the negative logarithm (base 10) of the hydrogen-ion concentration ($pH = -\log[H^+]$).

| Wastewater stream | Flow (L/min) | pH |
|-------------------|--------------|-----|
| 1 | 5 | 5.5 |
| 2 | 20 | 6.5 |
| 3 | 25 | 8.5 |

5. Perform a materials balance on substrate (S) around a chemostat (completely mixed flow reactor without recycle) assuming a first-order removal ($dS/dt = -kS$) for substrate with a rate constant = 0.5 hr^{-1} . The influent substrate concentration is 150 mg/L , and 90% removal is desired. Determine the detention time in hours for the chemostat, assuming steady-state conditions.

Note: this is actually the 'reactor model' for the CMF reactor, which we haven't covered in class. However, since steady-state conditions are assumed, the problem reduces to our Chapter 4 analyses.

6. The following are total coliform counts (colonies per 100 ml sample) measured at 10 different locations on Lake Malawi on the same day during June 2010: 123, 116, 122, 110, 175, 126, 125, 111, 118, 117.
- a. Find the sample mean and median
 - b. What feature in this data set is responsible for the substantial difference between the two?
 - c. Construct a histogram and a CDF.