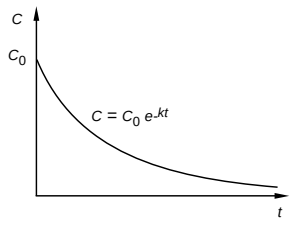
MATH 164, Spring 2001 **Due Date:**_____ **Name(s):** _____

Honors Project 0: Drug Dosage

Background

Two facts will be important in this project.

First, the concentration of a drug in the bloodstream from a single dose decreases with time. (Can you see why?) In general, the rate of decrease is proportional to the amount present: thus if $C = C(t)$ is concentration (in mg/mL) as a function of time t (in hours), then



$$\frac{dC}{dt} = -kC$$

where $k > 0$ is a constant, known as the *elimination constant* of the drug. It follows that

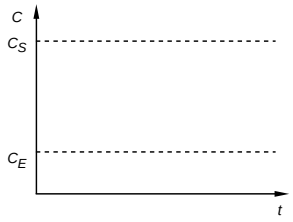
$$C = C_0 e^{-kt}$$

where C_0 is the initial concentration, or

$$C = C_0 \left(\frac{1}{2}\right)^{\frac{t}{t_H}}$$

where t_H is the half-life of the drug.

Second, for most drugs there is an effective concentration level C_E above which C must stay if the drug is to be effective, and a safe concentration level $C_S > C_E$ below which C must stay if the drug is to be safe.

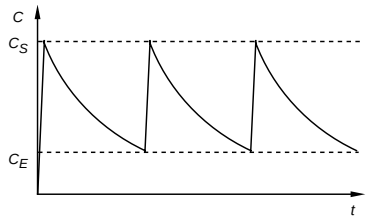


The Problems

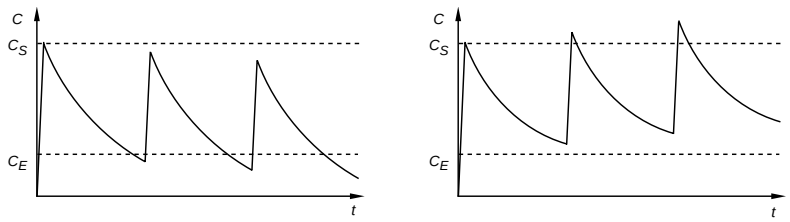
1. You are working with a drug whose elimination constant k is known. (In general, what might k depend on? How might you determine k in practice?) Design a schedule for long-term administration of the drug that will:

a) get the concentration to an effective level as soon as possible,
b) keep the concentration below a known safe level C_S, and
c) keep the concentration above a known effective level C_E.

You may assume that upon administration the drug immediately becomes completely mixed in the bloodstream at its maximum concentration level. (Is this assumption reasonable?) *Hint*: Over the long-term, concentration levels should look something like this:



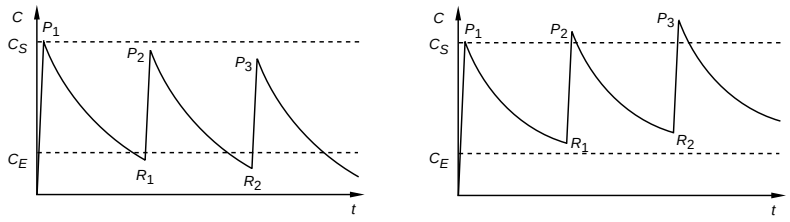
Two types of administration schedule you will want to avoid are illustrated below:



What is wrong with these schedules, and what led to the problems?

2. So far, your computations have been quite general in nature. Find data for a real drug[1], and report the administration schedule you designed in concrete terms.

Two sequences of interest in understanding the long-term effects of drugs are the (sequence of) *peak concentrations* $\{P_n\}$ and the (sequence of) *residual concentrations* $\{R_n\}$. The *peak concentration* P_n is the concentration of the drug immediately after the nth dose, and the *residual concentration* R_n is the concentration of the drug immediately before the $n+1$st dose.



3. Assuming that a dose of a drug that raises the bloodstream concentration level by C_0 is taken at regular time intervals t_0, that the elimination constant k of the drug is known, and that upon administration the drug immediately becomes completely mixed in the bloodstream at its maximum concentration level:

a) find closed form expressions for P_n and R_n,
b) find $P_\infty = \lim_{n\to\infty} P_n$,
c) describe in pharmaceutical terms the significance of P_∞,
d) find $R_\infty = \lim_{n\to\infty} R_n$, and
e) describe in pharmaceutical terms the significance of R_∞.

[1]Consult the *Physicians Desk Reference*, aka "the *PDR*".