1. **(1 pt) mathbioLibrary/setABiocLabs/Lab121_K3_drug.pg**
Because of the accuracy of WebWork, you should use 5 or 6 significant figures on this problem.

Several of you are considering careers in medicine and biotechnology. Drug therapy and dose response is very important in the treatment of many diseases, particularly cancer. Since cancer cells are very similar to your normal body cells, their destruction relies on very toxic drugs. There are some very fine lines in certain cancer treatments between an ineffective dose, one that destroys the cancer, and one that is toxic to all cells in the body. At the base of many of the calculations for these treatments are simple mathematical models for drug uptake and elimination.

a. The simplest situation calls for an injection of the drug into the body. In this case, a fixed amount of the drug enters the body, then its quantity decreases exponentially as the drug is metabolized and excreted from the body. Suppose that $A_0 = 14\ \mu$g of a particular drug is injected into the body, and that it has been determined that the half-life of the drug in this patient is 30 days. A model for the amount of drug in the body is given by

$$A(t) = 14e^{-kt}.$$

where k depends on how the drug is metabolized and excreted from the body. From the half-life given above, find the value of k.
$k =$ _____ .

Determine how long the drug is effective, if it has been found that the patient must have at least 2.8 μg in his body.
Effective for $t_e =$ _____ days.

For graphing purposes, find the A-intercept and the horizontal asymptote.
A-intercept = _____ μg.
Horizontal asymptote at $A =$ _____ μg.

b. With new materials being developed, the drug can be inserted into polymers that slowly decay and release the drug into the body (See **Norplant**). This delivery system can prevent large toxic doses in the body and maintain the drug level for longer at theurapeutic doses. Suppose that the amount of drug delivered by this new type of drug delivery system satisfies the model

$$B(t) = B_0(e^{-kt} - e^{-qt}),$$

where $B_0 = 16.549(\mu\text{g})$, $q = 0.15(\text{day}^{-1})$, and k has the same value as in Part a. The first decaying exponential is from the body metabolism, while the second one is from the polymer degradation. (It can be shown with integration that this is the same amount of drug as delivered in Part a.) Once again assume that the patient must have at least 2.8 μg in his body to be effective. Over what time period (if any) is this therapy effective. Is this time period longer or shorter than your answer from Part a?

Effective for $t_e =$ _____ days.
LONGER or SHORTER _____

Find the derivative of $B(t)$.
$B'(t) =$ _____

Find the time, t_{max}, where the maximum occurs and the value of $B(t_{max})$.
$t_{max} =$ _____ days
$B(t_{max}) =$ _____ μg.

After the maximum occurs, the amount of drug in the body decreases with it first dropping more and more rapidly, then after a point of inflection the rate of loss decreases. Find the second derivative of $B(t)$.
$B''(t) =$ _____

Find the point of inflection for this drug.
Time for point of inflection $t_i =$ _____days.
Determine both the amount of drug in the body at that time and the rate of change in drug at that time, i.e., find
$B(t_i) =$ _____ μg.
$B'(t_i) =$ _____ μg/day.

For graphing purposes, find the B-intercept and the horizontal asymptote.
B-intercept = _____μg.
Horizontal asymptote at $B =$ _____ μg.

c. In your Lab Report, create a single graph showing both solutions, $A(t)$ and $B(t)$, for 100 days ($t \in [0, 100]$). On the graph of $B(t)$ locate and label the maximum and the point of inflection. Write a brief paragraph describing how you determined the length of time that the drug was effective in both situations. Also, discuss how you found the maximum and the point of inflection. Write a brief discussion on which treatment you consider to be superior and why?