Project 4: Safe and Effective Drug Dosage – Reprise
AVAILABLE: [Day 36] DUE: [Day 41]

Take another look at Project 3, part C:
A problem facing physicians is the fact that, for most drugs, there is a concentration below which the drug will be ineffective and a concentration above which the drug will be dangerous (or perhaps even lethal). Consider the drug in Experiment 2 (of Project 3): An injection of 1.5 mg/ml was administered, and four hours later the concentration of this drug in the body was 0.75 mg/ml.

In Project 3, you modeled the rate at which this drug is eliminated from the body as a differential equation of the form $\frac{dy}{dt} = -ky$, where y is the concentration of the drug in the body at time t, and k is a constant.

1. For the drug in Experiment 2, researchers have found that the minimum effective level is 0.45 mg per ml, and the maximum safe level is 2.15 mg per ml. If a dose of 1.5 mg/ml of this drug is administered every 6 hours, the concentrations of the drug in the body at the peaks (that is, immediately after receiving the injection) can be modeled by a *geometric series*.
   a. Find an expression for this geometric series. That is, identify the first term and the common ratio. What is the sum of this series?
   b. In Project 3, you have already determined that this dosage level will eventually exceed the maximum safe level. Use what you know about geometric series to find a safe and effective dosage schedule (dosage level and time between doses) for this drug.
   Since you've already solved this problem in your earlier work, you could prove that your earlier answer is correct by showing that the sum of the geometric series which represents your earlier solution does indeed stay below the maximum safe level.

2. As you did in Project 3, solve this problem again assuming that the minimum effective level is 0.5 mg per ml, and the maximum safe level is 1.65 mg per ml. Since the range of acceptable values is much narrower, it is impossible to achieve an acceptable dosage level by adjusting only the time between doses and keeping the dosage level constant. Again, *use what you know about the sum of a geometric series to find an acceptable dosage pattern*.

Write a report of your findings answering these questions. Submit your findings as a laboratory report with a cover letter on your professional letterhead stationery. This report is to be word processed, and submitted by uploading it to your folder for this course in Educator.

The audience for your paper: Your reader will be a professional scientist working for the pharmaceutical firm, but this person may not have taken a recent course in calculus. Very probably such a professional would have taken a course in calculus more than five years ago, and may be a bit rusty on the details of your computations.

Grading Criteria:
Your paper will be graded on format, writing style, mathematical content and correctness, and evidence of synthesis and integration.

- **Format: 10%**
  Your paper should give a good professional first impression. It should be word-processed. Use the Equation Editor available in Word, or use the text-editing feature of Maple to write any complicated mathematical formulas and then cut-and-paste them into your document.
- **Writing Style: 15%**
  This is a formal report, written clearly and simply in good business English using appropriate sentence structure and grammar. Use a spell checker and ask a friend to proofread your final paper. Remember that the spell checker will not alert you to incorrect words that are spelled correctly, such as “there” when you mean “their.”

- **Mathematical Content and Correctness: 60%**

Your work should answer the questions clearly and be mathematically correct. In particular, you are to solve this problem using geometric series. Discuss your calculations and conclusions in a way that is clear to a professional scientist.
Remember: your reader has taken calculus, but that was a long time ago.

- **Synthesis and Integration: 15%**
  While a *B* paper will present a correct solution, an *A* paper will clearly present the mathematical reasoning leading up to your conclusions. The solutions to the problems in this project require you to use problem-solving strategies you have been learning throughout this course. You need to present the solution of a differential equation, and show how concentrations of the drug in the body can be modeled using a geometric series. Think carefully about what is happening in the body when someone takes repeated doses of a medicine.

Submit your paper by uploading it to your folder for Calculus in [course management system]. It is due by 4 pm on [Day 41].