1. Use logarithmic differentiation to find the derivative:

$$f(x) = \frac{e^{3x}(x + 1)^6(x^3 - 2)^4}{\sqrt{2x - 7}}$$

2. (a) Find all values for $x$ which make the equation true: $x \ln(x + 1) = 2x$

(b) Write the following expression in the form $2^{ax+b}$ for some $a$ and $b$: $\frac{16^x}{2 \cdot 4^{2x}}$

3. Find $g'(1)$, where $g(x) = e^{3x^2-2x+1}$

4. For the following function, determine the $x$- and $y$-value of each critical point, and then use the first or second derivative test to determine whether each point is a maximum, minimum, or neither:

$$f(x) = \frac{x}{\ln(x)}$$

5. To make killer robots, one uses the radioactive isotope Halloweenium-X, which has a decay constant of $\lambda = .002$.

(a) What is the half-life of Halloweenium-X?

(b) What differential equation is satisfied by the decay of Halloweenium-X?

(c) Use the differential equation to answer the question: how much Halloweenium-X is in a sample which is decaying at the rate of 4 grams per year?

6. A colony of flesh-eating zombies feeds on the living population of Earth and grows at a rate proportional to its size. (As with all zombie colonies) it starts with just one person, and after one year there are 2,500 zombies.

(a) Find the growth constant $k$ of the zombie colony.

(b) Find an equation $P(t)$ which describes the number of zombies in the colony at time $t$.

(c) Using this equation, how many years until the colony reaches 10,000 zombies?

7. An evil collector sells his collection of cursed talismans for $4,000, deposits the earnings into his bank account, then abruptly disappears and is never heard from again. The account accrues interest compounded continuously for 100 years before someone discovers it, with a balance of $120,000. What was the annual interest rate for this bank account?

8. The concentration of a drug in the bloodstream of a patient, $t$ hours after injection, is given by:

$$f(t) = 5(e^{-2t} - e^{-2t}) \text{ units}$$

At what rate is the drug concentration changing after 4 hours?