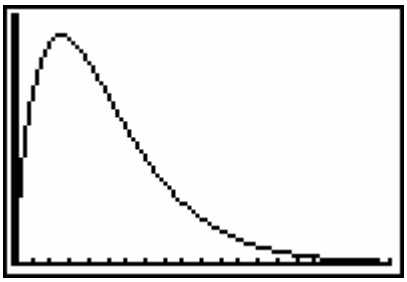
Guidelines for Solution:

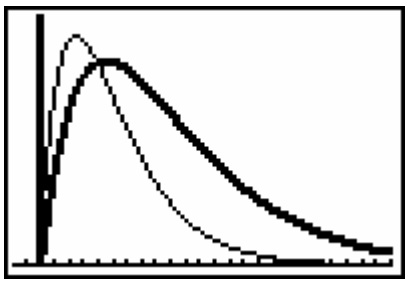
1. Students will need to find a suitable window. The graph looks like:



Students should be able to discuss some of the key features of the graph such as its intervals of increase and decrease, maximum point, domain and range for the context, areas of concavity, and points of inflection. This could be done with the aid of graphing technology.

2. The concentration appears to be highest at approximately 2.5 hours. At that point the concentration is approximately 183.72 parts per million. Students should verify this using calculus techniques.

3. The graph of a "time release" Vitamin C tablet should have a more gradual rate of decrease after it hits the maximum value. Such a graph, compared to the original might look like:



(Note: Students may want to draw the graphs by hand and then move to the graphing calculator to work with the parameters to see how to change the graph.)
The equation of the graph that is drawn is: $y = 100x(0.8)^x$. Students will probably use "guess and check" to create such an equation.

4. Given $y = bx(a)^x$, to find the maximum concentration, find the derivative and set it equal to 0.
Using the product rule, $y' = b(a)^x + bx(a)^x \ln a$
Setting the derivative = 0 and factoring: $0 = b(a)^x (1 + x(\ln a))$
Therefore, within this context, the maximum occurs when $x = -\frac{1}{\ln a}$.

Vitamin C-alculus
Summative Assessment

In many cases, we use simple mathematical models to explain problems.
For instance, when discussing the effectiveness of a drug in a patient's system,
we can state the half-life of the drug and given the concentration of the drug,
we can monitor it's concentration in the patient's system over time.

Actually, when a drug enters a patient's body,
the concentration level rises after a brief period of time rather than immediately.

For instance, assume a person takes a 500 mg tablet of Vitamin C,
the concentration of Vitamin C will be given by the equation

$$f(x) = 200x(0.67)^x$$

where $f(x)$ is the concentration in parts per million and x is the number of hours after the tablet is taken.

1. Sketch this function.
   State the domain and range for this function in this context.
   Using the TI-83, describe some of the key features of this graph.
   (It is not necessary to use differential calculus (derivatives) to discuss these key features.)
   Where is this function increasing? decreasing?
   Where is this function concave upward? concave downward?
   State the maximum point.
   What does this graph tell you about the concentration of Vitamin C in a person's body?

2. When is the concentration of Vitamin C the highest?
   Verify this using calculus techniques.

3. A "time-release" Vitamin C tablet releases Vitamin C to the body over time,
   instead of most of the Vitamin C being released to the body when the tablet is taken.
   If a company were looking at making a "time-release" Vitamin C tablet,
   a) what might its graph look like?
   b) what might its equation look like?

4. If an equation of the form: $y = bx(a)^x$ is used to model the behaviour of a drug,
   find the time when the maximum concentration of the drug occurs.
   Show that the maximum can be found by simply knowing a.

Drug Effectiveness – Assessment Rubric

	Level 1	Level 2	Level 3	Level 4
Knowledge and Understanding				
Verification of maximum value of a function, both numerically and in a general case #2 and #4	Attempts to find maximum value but significant errors in calculations or method	Finds maximum value using appropriate techniques but may contain inaccuracies	Finds maximum value using calculus techniques, most computations correct	Finds maximum value using calculus techniques and relates to the graph and context
Thinking, Inquiry, and Problem Solving				
Creation of a model for a time-release Vitamin C tablet #3	A model was used that addresses few aspects of the problem	A model was used that addresses some aspects of the problem	An appropriate model was created	An appropriate model was created that integrates all aspects of the problem/context
Communication				
Describes key features of the graph using appropriate terminology #1	Correctly identifies few of the key features of the graphs	Correctly identifies some of the key features of the graphs	Correctly identifies most significant key features of the graphs	Correctly identifies all key features of the graphs and interprets them fully