1. **(8 points)** Answer the questions below.

   (a) **(4 points)** Express $\int_2^5 3^x dx$ as a Riemann sum.

   (b) **(4 points)** Evaluate $\int_2^5 3^x dx$.

2. **(8 points)** Evaluate the following limits; if they cannot be evaluated, show why not and describe their behavior.

   (a) **(2 points)** $\lim_{x\to 1} \frac{x^2-4x+3}{\ln x}$

   (b) **(3 points)** $\lim_{x\to\infty} \frac{x^2}{e^x}$.

   (c) **(3 points)** $\lim_{x\to 0} \frac{\cot x}{\ln x}$.

3. **(8 points)** Answer the two following appropximation questions.

   (a) **(4 points)** Using a well-chosen tangent line approximation, approximate $\sqrt{405}$.

   (b) **(4 points)** Construct a function $f(x)$ with $\sqrt[3]{7}$ as a root, and, given the initial point $x_1 = 2$, use Newton's method to determine an approximation x_2 to $\sqrt[3]{7}$.

4. **(8 points)** A conical tank 2 meters in height and one meter in radius is filled to the brim with water and can drain through the bottom at a rate of 0.05 cubic meters per minute.

   (a) **(5 points)** How fast is the water level descending?

   (b) **(3 points)** After the water has drained to a depth of 1 meter, how fast is the water level descending?

5. **(8 points)** Answer the following questions realted to the shape of the graph of $f(x) = \frac{x^2+2x+6}{x-1}$.

   - **(3 points)** Where is it increasing? Where is it decreasing?

   - **(3 points)** Where is it concave up? Where is it concave down? Does it have any points of inflection?

   - **(2 points)** What are its critical points, and is each a maximum, a minimum, or neither?

6. **(8 points)** You are constructing a window with the shape shown here of a rectangle of height h surmounted by a semicircle of radius r. You must construct the exterior edge of the window, as well as the three internal struts shown on the figure, using only 21 feet of edging. Find the value of r maximizing the area of the window.