INSTRUCTIONS: Books, notes, and electronic devices are not permitted. Write (1) your name, (2) section number, and (3) a grading table on the front of your bluebook. **Start each problem on a new page. Simplify your answers.** A correct answer with incorrect or no supporting work may receive no credit, while an incorrect answer with relevant work may receive partial credit. Unless otherwise indicated, **show all work.**

1. (15 points)
   
   (a) Write in expanded form: \( \sum_{i=1}^{4} \frac{x^i}{i+1} \).
   
   (b) Write in sigma notation: \( S = \frac{1}{2} - \frac{3}{4} + \frac{9}{6} - \frac{27}{8} + \frac{81}{10} \).
   
   (c) Find the value of \( \sum_{i=1}^{10} (2i^2 - 2i - 6) \).
      
      (Hint: You may use the formulas at the end of the test.)

2. (10 points) Use Newton’s Method with an initial approximation of \( x_1 = 0 \) to find \( x_3 \), the third approximation to the root of the equation \( 2x^3 = 1 - x \).

3. (10 points) Estimate the area under the graph of \( f(x) = \frac{3}{x^4 + 1} \) from \( x = 2 \) to \( x = 4 \) using four approximating rectangles of uniform width and midpoint values. Leave your answer unsimplified.

4. (10 points) Evaluate the following indefinite integrals.
   
   (a) \( \int \frac{-2x^2 + 3x - 5\sqrt{x} + 1}{\sqrt{x}} \, dx = \)
   
   (b) \( \int \left( \frac{2}{3} \csc x \cot x + 2 \sec^2 \frac{x}{2} \right) \, dx = \)

5. (15 points) Use geometry to evaluate the following definite integrals.
   
   (a) \( \int_{2}^{10} \frac{t}{2} \, dt = \)
   
   (b) \( \int_{-2}^{1} (5|x| - 10) \, dx = \)
   
   (c) \( \int_{-9}^{9} \left( 3 - \sqrt{81 - x^2} \right) \, dx = \)
6. (10 points) A definite integral is defined as a limit of a Riemann sum. Match each integral on the left with the equivalent limit on the right. No explanation is necessary.

(a) \( \int_{0}^{3} x^3 \, dx \)  
(b) \( \int_{1}^{3} x^3 \, dx \)  
(c) \( \int_{3}^{6} x^3 \, dx \)  
(d) \( \int_{0}^{3} (x + 6)^3 \, dx \)

(i) \( \lim_{n \to \infty} \sum_{i=1}^{n} \left( \frac{3i}{n} \right)^3 \left( \frac{3}{n} \right) \)  
(ii) \( \lim_{n \to \infty} \sum_{i=1}^{n} \left( 3 + \frac{3i}{n} \right)^3 \left( \frac{3}{n} \right) \)  
(iii) \( \lim_{n \to \infty} \sum_{i=1}^{n} \left( 6 + \frac{3i}{n} \right)^3 \left( \frac{3}{n} \right) \)  
(iv) \( \lim_{n \to \infty} \sum_{i=1}^{n} \left( 1 + \frac{2i}{n} \right)^3 \left( \frac{2}{n} \right) \)

7. (15 points) Let \( k \) equal the constant acceleration required to increase the speed of a car from 22 ft/sec (15 mph) to 110 ft/sec (75 mph) in 5 seconds.

(a) Find \( k \).

(b) How far does the car travel in that time?

8. (15 points) A piece of wire 8 m long is cut into two pieces. One piece is bent into a square and the other is bent into a circle. How should the wire be cut so that the total area enclosed is (a) a maximum? (b) a minimum?

**Extra Credit** (10 points)

A window has the shape of a rectangle topped by an equilateral triangle. If the perimeter of the window is 20 feet, find the dimensions of the rectangle that will maximize the amount of light admitted.

**Formulas**

\[
\sum_{i=1}^{n} i = \frac{n(n + 1)}{2}
\]

\[
\sum_{i=1}^{n} i^2 = \frac{n(n + 1)(2n + 1)}{6}
\]