1. (10 points) State the (First) Fundamental Theorem of Calculus.

2. (10 points) Compute $\sum_{i=2}^{5} \frac{i}{i + 1}$. You do not need to simplify.

3. (10 points) The graph below shows the velocity of a proton in m/s after $t$ seconds have elapsed. Estimate how far the proton travels in the first 2 seconds using 4 subintervals.

4. (15 points) The rate of growth of a population of rabbits is given by $P'(t) = \frac{100e^{-0.05t}}{(1 + 2e^{-0.05t})^2}$, where $t$ is in years. If the initial population was 1000 rabbits, what is the population after 4 years? You may use your calculator, but be sure to tell me what you are asking it to do!

5. (15 points) Without using your calculator, compute $\int_{1}^{3} 4x^3dx$. 
6. (10 points) Let \( f(x) = \sqrt{x} \).

(a) Write a definite integral that gives the exact area under the graph of \( f(x) \) between \( x = 0 \) and \( x = 4 \).

(b) Use your calculator to compute the integral from (a).

7. (20 points) True or False.

(a) A definite integral always represents the area between the graph of a function and the \( x \)-axis.

(b) In the integral \( \int_0^4 a(t)dt \), if the units of \( a(t) \) are \( m/s^2 \) and the units of \( t \) are seconds, then the units of the integral are meters.

(c) Estimating an integral using left endpoints always gives an underestimate for the area under a curve.

(d) If \( \int_a^b f(x)dx = 3 \) and \( \int_a^b g(x)dx = -5 \), then \( \int_a^b [f(x) - g(x)]dx = 8 \).

(e) If \( f \) is the function graphed to the right and the areas are as shown, then \( \int_1^5 f(x)dx = 13 \).

8. (20 points) Let \( F(x) = \int_1^x \frac{3t^2 - e^t}{3t^2 + e^t} dt \)

(a) (10 points) What is \( F'(x) \)?

(b) (5 points) What is \( F(1) \)?

(c) (5 points) What is \( F(2) \)?

9. (10 points) Find the area of the region between the graph of \( f(x) = x^2 - 5 \) and the \( x \)-axis between \( x = 0 \) and \( x = 4 \). You may use your calculator, but be sure to show me what you are using it for.
10. (10 points) The graph of \( f(x) \) is shown below. On the same set of axes, sketch a graph of \( F(x) = \int_0^x f(t) \, dt \) if \( F(0) = 1 \).

![Graph of f(x)](image)

11. (20 points) Several values of \( F(x) \) are shown in the table below.

<table>
<thead>
<tr>
<th>( x )</th>
<th>( F(x) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>-1</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
</tr>
</tbody>
</table>

(a) What is \( \int_1^3 F'(x) \, dx \)?

(b) Estimate \( \int_1^5 F(x) \, dx \).

12. (10 points) **Bonus!** Use the definition of the definite integral to compute \( \int_2^6 x^3 \, dx \). It may help to recall that \( \sum_{i=1}^n i^3 = \frac{n^2(n+1)^2}{4} \).