1. [9 pts] Evaluate the following limits if they exist. If a limit does not exist, state why.
   a) \[ \lim_{x \to 0} \frac{8 - 5x^5}{6 + 3x^5 - 2x} \]
   b) \[ \lim_{x \to 4} \frac{x^2 - 16}{x^2 + 3x - 28} \]
   c) \[ \lim_{x \to -\infty} (4 + e^{2x}) \]

2. [28 pts] Differentiate the following functions. You do not need to simplify your answers.
   a) \[ f(x) = e^{8x^7} \ln x \]
   b) \[ g(x) = \ln \sqrt{x^3 + 3} \]
   c) \[ h(x) = \frac{2 + \tan x}{\cos x} \]
   d) \[ y = \left(3x^2 - \frac{1}{x} + 2\right)^4 \]
3. [10 pts] Use the Limit Definition of the derivative to verify that \( f'(x) = 2x - 6 \), when \( f(x) = x^2 - 6x \)

4. [8 pts] Find \( \frac{dy}{dx} \) by implicit differentiation if: \( e^x + x\ln y = 4 \)

5. [6 pts] Find the equation of the tangent line to \( y = e^x + \ln x \) at \( (1, e) \).

6. [9 pts] a. Write as a single logarithm: \( \frac{1}{2}\ln(x^3 + 2) - 2\ln x \)

   b. Solve for \( x \): \( e^{3x + 2} = 6 \)

   c. Solve for \( x \): \( \ln(x + 1) = 4 \)
7. [10 pts] A 13 foot ladder leans against a vertical wall. The bottom of the ladder is pushed toward the wall at a rate of 2 feet per second. How fast is the top of the ladder sliding up the wall when the base of the ladder is 5 feet from the wall? Be sure to include units.

8. [10 pts] Find the absolute maximum and minimum values of \( f(x) = 2x^3 - 15x^2 + 24x \) on the interval \([0, 3]\) Show all work.

Absolute minimum \( f(\text{___}) = \text{____} \)

Absolute maximum \( f(\text{___}) = \text{____} \)

9. [6 pts] Use calculus to find on what interval of \( x \) \( y = 10x - e^x \) is increasing.

10. [10 pts] When sending a rectangular package a certain shipping company has the condition that the sum of the three dimensions cannot be larger than 48 inches. Find the dimensions of the rectangular package with square ends that has the maximum volume that can be shipped by this company.
11. [42 pts] Integrate the following. You must show all work to receive full credit including the use of the Fundamental Theorem of Calculus. Any u-substitution must be clearly stated.

a) \[ \int (3x^2 + 2)e^{x^3 + 2x + 7} \, dx \]

b) \[ \int \frac{\sec^2 x}{\tan x} \, dx \]

c) \[ \int \frac{1}{3x - 5} \, dx \]

d) \[ \int \frac{x^2 + 1}{x} \, dx \]

e) \[ \int \frac{1}{x \ln x} \, dx \]

f) \[ \int x^4 \sin x^5 \, dx \]

g) \[ \int \frac{x}{\sqrt{2 - x^2}} \, dx \]
12. [4 pts] If \( \int f(x)\,dx = e^x \sin x + C \), then find \( f(x) \).

13. [6 pts] An object is thrown vertically upwards with an initial velocity of 160 ft/sec from a height of 5 feet. If the force of gravity is \( a(t) = -32 \) ft/sec\(^2\) find a position function, \( p(t) \), for the object.

14. [8 pts] Below are values for a function \( y = f(x) \). Approximate \( \int_{0}^{12} f(x)\,dx \) using six subintervals and right-hand endpoints.

<table>
<thead>
<tr>
<th>( x )</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>2</td>
<td>5</td>
<td>9</td>
<td>10</td>
<td>14</td>
<td>16</td>
<td>17</td>
</tr>
</tbody>
</table>

15. [8 pts] Find the area of the region bounded by the graphs of \( y = x^2 \) and \( y = 2 - x \).
16. [10 pts] Consider the region bounded by $y = \sqrt{x}$, $x = 1$, and $y = 0$. Use the disk method to find the volume of the solid obtained by rotating this region about the x-axis. Make a sketch.

17. [10 pts] Find the volume of the solid obtained by rotating about the y-axis the region bounded by $y = 2x$, $y = 0$ and $x = 1$. Make a SKETCH.

18. [6 pts] A city grew exponentially from 1900 to 2000. In 1950 there were 200 people living in the city. In the year 2000 there were 40,000 people living in the city. How many people lived in the city in 1900?