Please read and follow the following directions:
1. Do all work on the space provide.
2. Box your answer when possible.
3. All answers are to be exact and simplified.
4. No Electronic Devices!
5. Students are not allowed to leave and return when the exam starts. Thus, if you need to use the restroom, do so now!
6. If time permits, go back and check your work!
7. Cheating is prohibited, so please keep your eyes on your paper!
1. (2pts) Determine all critical points of $f(x) = \sqrt{2x - x^2}$.
2. (4pts) Let be a curve in $\mathbb{R}^2$. Find the value(s) of $c$ that satisfy the conclusion of the Mean Value Theorem for the function $f(x) = \sin^{-1}x$ in $[-1,1]$. 
3. (6pts) Suppose that $y' = x^2 - x - 6$ is the first derivative of a continuous function $y = f(x)$.

a) Find the intervals (if applicable) of increasing and decreasing.

b) Find the intervals (if applicable) of concavity.

c) Use the information from part (a) and (b) to sketch the general shape of the graph of $f$. 

4. (2pts) The graph below shows the first and second derivatives of a function $y = f(x)$. Use this information to sketch an approximate graph of $f$, given that the graph passes through the point $P$. 

![Graph showing first and second derivatives of a function with point P]
5. (4pts) For what value(s) of the constant $k$ will the curve $y = x^3 + kx^2 + 3x - 4$ have exactly one horizontal tangent?
6. (2pts each) Find the following limits. You may use any method of your choice, but your work must be justified!

a) \[ \lim_{x \to 0} \frac{x^2}{\ln(\sec x)} \]

b) \[ \lim_{x \to 0} \frac{3^x - 1}{x - 1} \]

c) \[ \lim_{x \to \infty} (\ln 2x - \ln(x + 1)) \]
d) \( \lim_{x \to 0} \frac{\sin x}{\tan x} \)

e) \( \lim_{x \to \infty} \left( \frac{x^2 + 2}{x + 1} \right)^x \)

f) \( \lim_{x \to 0} \frac{e^x}{x^2} \)
7. If \( v'(t) = \frac{6}{1 + t} + \sec^2 t \) and \( v(0) = 1 \), find \( v(t) \).
8. The rectangle shown below has one side on the positive $y$-axis, one side on the positive $x$-axis, and its upper right-hand vertex on the curve $y = e^{-x^2}$. What dimensions give the rectangle its largest area, and what is that area?