1. Circle the letter of the following assertions which are \textit{always} true.

   (a) If $f(x)$ is a function such that $f(3) > 0$ and $f(7) < 0$, then there exists $3 < c < 7$ such that $f(c) = 0$.

   (b) If $f(x)$ is continuous at $x = a$, then $f(x)$ is differentiable at $x = a$.

   (c) If $f''(5) = 0$, then $f(x)$ has an inflection point at $x = 5$.

   (d) If $f'(9) = 0$ and $f''(9) > 0$, then $f(x)$ has a local minimum at $x = 9$.

   (e) If $y$ is twice continuously differentiable, then $D^2 y = (Dy)^2$.

   (f) If $f(x)$ is continuous and even on $[-3, 3]$, then $\int_{-3}^{3} f(x) dx = 0$.

   (g) If $f(x)$ has a local maximum at $x = 2$, then $f(x) \leq f(2)$ for all $0 \leq x \leq 4$.

   (h) If $f(x)$ is differentiable on $[3, 6]$, $f(3) = 2$ and $f(6) = 8$, then there exists $3 < c < 6$ such that $f'(c) = 2$.

   (i) If $f(x)$ is continuous on $[-4, 9]$, $\int_{-4}^{9} f(t) dt = 5$, and $\int_{0}^{9} f(t) dt = 8$, then $\int_{0}^{-4} f(t) dt = 3$.

   (j) If $f(x)$ is continuous on $[1, 3]$, and $\int_{1}^{3} f(x) dx$ represents the area bounded by $y = f(x)$, $y = 0$, $x = 1$ and $x = 3$, then $f(x) \geq 0$ on $[1, 3]$.
2. Consider \( L = \lim_{h \to 0} \frac{(\pi + h)^2 \sin(\pi + h)}{h} \)

(a) Find a function \( f(x) \) and a point \( a \) so that \( L = f'(a) \).

(b) Use derivatives to find the value of \( L \).

3. If \( f(x) \) is differentiable, find the following in terms of \( f' \) :

(a) \( \frac{d}{dx} \frac{f(x)}{1 + \cos^2 x} \)

(b) \( \frac{d}{dx} f(f(x)) \)

4. A particle starts at \( x = 0 \), and moves along the \( x \)-axis so that its velocity is \( v(t) = 3 - \sqrt{t} \) m/s for \( t \geq 0 \).

(a) Find its position at a general time \( t \).

(b) Find the largest \( x \)-coordinate that the particle reaches.
5. Consider \( \lim_{n \to \infty} \sum_{i=1}^{n} \sqrt{\frac{2i}{n}} \left(3 + \frac{4i}{n}\right) \cdot \frac{2}{n} \).

(a) Write this limit as an integral, with a specified integrand and limits of integration. 

(b) Evaluate this integral.

6. Let \( f(x) = \begin{cases} x + 2 & \text{if } x < 0 \\ \sqrt{4 - x^2} & \text{if } 0 \leq x \leq 2 \end{cases} \)

Use geometry to evaluate \( \int_{-3}^{2} f(x) \, dx \)

7. (a) State the Fundamental Theorem of Calculus in the derivative form.

(b) If \( g(x) = \int_{3}^{x} \frac{1}{4 - t^2} \, dt \) for \( t > 2 \), find \( g'(x) \).
(c) Find \( \frac{d}{dx} \int_x^{x^2} \sin(t^2)dt \)

8. (a) State the Fundamental Theorem of Calculus in the antiderivative form.

(b) Evaluate \( \int_1^4 \frac{1}{\sqrt{x}} + x^3 dx \)

(c) Evaluate \( \int_1^3 \left( \frac{x^2 + 1}{x} \right)^2 dx \)

9. Evaluate \( \int_0^{(\pi/6)^{1/4}} x^3 \sec^2(x^4 + \frac{\pi}{6}) dx \)
10. Evaluate $\int x\sqrt{1-x} \, dx$ 

11. Find the finite area bounded by $x \geq 0, y = x$ and $y = \sin \left( \frac{\pi}{2} x \right)$.

12. The region bounded by $y = 0, y = \sqrt{1-x^4}, x = 0$ and $x = 1$ is rotated about the $x$-axis. Find the volume of the resulting solid.