1. Find the absolute and local extrema for \( f(x) = \begin{cases} \frac{x^2}{2} & \text{if } -1 \leq x \leq 0 \\ 2 - x^2 & \text{if } 0 < x \leq 1 \end{cases} \)

2. Find the absolute maximum and minimum of the given function on the given interval.
   
a) \( x^3 - 5x^2 + 3 \) on \([-1, 3]\)
   
b) \( x \ln x \) on \([1, e]\)
3. If \( f(x) = x - x^3 \), verify \( f(x) \) satisfies Rolle’s Theorem on the interval \([0, 1]\) and find all \( c \) that satisfies the conclusion of the Rolle’s Theorem.

4. If \( f(x) = \frac{1}{x} \), verify \( f(x) \) satisfies the Mean Value Theorem on the interval \([1, 10]\) and find all \( c \) that satisfies the conclusion of the Mean Value Theorem.
5. If \( f(x) = 5x^{2/3} - 2x^{5/3} \), find the intervals where \( f(x) \) is increasing/decreasing and find all local extrema of \( f(x) \).

6. Find the concavity of \( f \) if \( f'(x) = \frac{\ln{x}}{x} \).
7. In each part, give the intervals where \( f \) is increasing/decreasing and list the \( x \)-coordinates of the local maximum and local minimum \( f \). Assume the domain of \( f \) is \((0, 8)\).

\[ \text{a.) The above curve is the graph of } f. \]

\[ \text{b.) The above curve is the graph of } f'. \]

8. In each part, give the intervals of concavity of \( f \) and give the \( x \)-coordinates of the inflection points of \( f \). Assume the domain of \( f \) is \((0, 8)\).

\[ \text{a.) The above curve is the graph of } f. \]

\[ \text{b.) The above curve is the graph of } f'. \]

\[ \text{c.) The above curve is the graph of } f''. \]
9. Find the intervals of concavity and inflection points if $f(x) = xe^{-2x}$.

10. A cardboard rectangular box holding 32 cubic inches with a square base and no top is to be constructed. If the material for the base costs $2 per square inch and material for the sides costs $5 per square inch, find the dimensions of the cheapest such box.
11. Find the limit of each of the following:

a.) \( \lim_{x \to 0} \frac{\arcsin(3x)}{2x} \)

b.) \( \lim_{x \to 0} \frac{\sin x - x}{5x^3} \)

c.) \( \lim_{x \to \infty} \frac{\ln x}{\sqrt{x}} \)
d.) \[ \lim_{x \to 0^+} x^3 \ln x \]

e.) \[ \lim_{x \to 1} \left( \frac{1}{\ln x} - \frac{1}{x - 1} \right) \]
f.) \( \lim_{x \to 0^+} (\sin x)^{\tan x} \)

g.) \( \lim_{x \to \infty} \left(1 + \frac{2}{x}\right)^{4x} \)
12. Find an antiderivative of \( f(x) = \frac{1}{\sqrt{1-x^2}} - \frac{1+x-x^3}{x} + \frac{1}{1+x^2} \).

13. Given \( f'(x) = 2e^x - 4\sin(x) + 3^x \), \( f(0) = 1 \), find \( f(x) \).
14. Find the vector functions that describe the velocity, $\mathbf{v}(t)$, and position, $\mathbf{r}(t)$, of a particle that has an acceleration of $\mathbf{a}(t) = (\sin t, 2e^t)$ given that the initial velocity is $\mathbf{v}(0) = (1, -1)$ and the initial position is $\mathbf{r}(0) = (0, 0)$.

15. Estimate the area under the graph of $f(x) = 2 - \sqrt{x}$ from $x = 2$ to $x = 4$ using four approximating rectangles and left endpoints. Sketch the graph of $f$ and the approximating rectangles.
16. Find an expression for the exact area under the graph of $f(x) = x^3 - 2x + 3$ on the interval $[1, 4]$. Do not evaluate the limit.