1. If \( f(x) = \sin \left( x^2 e^{x^2} \right) \), find \( f'(x) \).

2. If \( f(t) = \frac{18}{3 + t^2} \), find \( f'(t) \).

3. If a snowball melts so that its surface area decreases at a rate of 4 cm\(^2\)/min, find the rate at which the diameter decreases when the diameter is 39 cm.

4. If \( f(x) = x (\ln x)^{-1} \), find \( f'(e^3) \).

5. The position (s in meters, and \( t \) in seconds) function of a particle is given by \( s = t^3 - 3t^2 - 5t \), for \( t \geq 0 \). When does the particle reach a velocity of 139 meters per second?

6. If \( f(x) = \ln \left| \frac{x^2 - 4}{x^2 + 1} \right| \).

7. A machinist is required to manufacture a circular metal disk with area 1,000 cm\(^2\).
   (a) What radius (exact and approximate to three decimal places) produces such a disk?
   (b) If the machinist is allowed an error tolerance of ±5 cm\(^2\) in the area of the disk, how close to the ideal radius in part(a) must the machinist control the radius (three decimal places)?

8. If \( f(3) = 4 \), \( g(3) = 2 \), \( f'(3) = -5 \), and \( g'(3) = 6 \), find each of the following:
   (a) \( (f + g)'(3) \)
   (b) \( (f \cdot g)'(3) \)
   (c) \( \left( \frac{f}{g} \right)'(3) \)
   (d) \( \left( \frac{f}{f - g} \right)'(3) \)

9. Use the definition of the derivative to find \( f'(-2) \), where \( f(x) = x^3 - 2x \).

10. Find an equation of the tangent line to curve \( y = x^3 - 2x \) at the point \((2, 4)\).

11. **Optional Problem:** Use a graph to find \( \delta \) a number such that \( |\sqrt{4x + 1} - 3| < 0.6 \) whenever \( |x - 2| < \delta \).

12. If \( g(x) = \sqrt{3 - 5x} \), find the domain of \( g'(x) \).

13. Evaluate the limit.
   \[
   \lim_{x \to 0} \frac{(2 + x)^{-1} - 2^{-1}}{x}
   \]
14. Find the derivative of the function.

\[ f(x) = 14 - 3x + 5x^2 \]

15. If a cylindrical tank holds 100,000 gallons of water, which can be drained from the bottom of the tank in an hour, then Torricelli’s Law gives the volume of water remaining in the tank after \( t \) minutes as

\[ V(t) = 100000 \left( 1 - \frac{t}{65} \right)^2, \quad 0 \leq t \leq 60. \]

Find the rate at which the water is flowing out of the tank (the instantaneous rate of change of \( V \) with respect to \( t \)) as a function of \( t \).

16. Determine where \( f \) is discontinuous.

\[ f(x) = \begin{cases} \sqrt{-x} & \text{if } x < 0 \\ 3 - x & \text{if } 0 \leq x < 3 \\ (3 - x)^2 & \text{if } x > 3 \end{cases} \]

17. If

\[ f(t) = \frac{13}{3 + t^2} \]

find \( f'(t) \).

18. At what point is the function \( f(x) = |6 - x| \) not differentiable.

19. For \( x = 5 \), determine whether is continuous from the right, from the left, or neither.

![Partial Graph](image_url)
20. Differentiate.

\[ g(x) = x^7 \cos x \]

21. Find the points on the curve \( y = 2x^3 + 3x^2 - 12x + 1 \) where the tangent is horizontal.

22. **Optional Problem:** Use a graph to find a whole number \( N \) such that

\[ \left| \frac{6x^2 + 5x - 3}{2x^2 - 1} - 3 \right| < 0.3 \]

whenever \( x > N \).

23. Find the equation of the tangent to the curve at the given point.

\[ y = \sqrt{1 + 4 \sin x}, \quad (0, 1) \]

24. Find the limit.

\[ \lim_{x \to \frac{\pi}{4}} \frac{\sin x - \cos x}{\cos 2x} \]

25. Calculate \( y' \).

\[ y = \sqrt{x} \cos \sqrt{x} \]

26. A spherical balloon is being inflated. Find the rate of increase of the surface area with respect to the radius \( r \) when \( r = 1 \) foot.

27. Differentiate the function.

\[ f(x) = \frac{\sqrt{7}}{x^5} \]

28. Find an equation of the tangent line to the curve.

\[ y = \frac{\sqrt{x}}{x + 6}, \quad \text{at the point } P(4, 0.2) \]

29. A plane flying horizontally at an altitude of 4 miles (mi) and a speed of 465 miles per hour (mph) passes directly over a radar station. Find the rate at which the distance from the plane to the station is increasing when it is 10 miles away (horizontal distance) from the station. Round the result to the nearest integer.

30. Find the limit if \( g(x) = x^5 \).

\[ \lim_{x \to 2} \frac{g(x) - g(2)}{x - 2} \]

31. A company makes computer chips from square wafers of silicon. It wants to keep the side length of a wafer very close to 16 mm. The area is \( A(x) \). Find \( A'(16) \)
32. Calculate $y'$.

$$xy^4 + x^2y = x + 3y$$

33. Find the first and the second derivatives of the function.

$$y = \frac{x}{3 - x}$$

34. If $f(t) = \sqrt{4t + 1}$, find $f''(2)$.

35. If $y = 2x^3 + 5x$ and $\frac{dx}{dt} = 3$, find $\frac{dy}{dt}$ when $x = 5$.

36. The volume of a cube is increasing at a rate of 10 cm$^3$ per minute. How fast is the surface area increasing when the length of an edge is 30 cm.

37. The point $P(4, 2)$ lies on the curve $y = \sqrt{x}$. If $Q$ is the point $(x, \sqrt{x})$, use your calculator to find the slope of the secant line $PQ$ (correct to six decimal places) for the value $x = 3.99$.

38. The displacement (in meters) of an object moving in a straight line is given by

$$s = 1 + 2t + \frac{t^2}{4},$$

where $t$ is measured in seconds. Find the average velocity over the time period $[1, 3]$.

39. Find the limit.

$$\lim_{x \to 5} (9x^2 + 7x + 3)$$

40. **Optional Problem:** For the limit, illustrate the definition by finding values of $\delta$ that correspond to $\varepsilon = 0.25$.

$$\lim_{x \to 1} (4 + x - 3x^3) = 2$$

41. Find the limit.

$$\lim_{x \to 0} \frac{x - 1}{x^2(x + 5)}$$

42. If $1 \leq f(x) \leq x^2 + 2x + 2$, for all $x$, find the limit.

$$\lim_{x \to -1} f(x)$$

43. Find the limit.

$$\lim_{x \to 2} \frac{2 - x}{|2 - x|}$$
44. Find \( y' \).

\[
y = \ln \left( x^2 e^x \right)
\]

45. Find the first and the second derivatives of the function.

\[
G(r) = \sqrt{r} + \sqrt[3]{r}
\]

46. Find the equation of the tangent line to the given curve at the specified point.

\[y = 4xe^x, \quad (0, 0)\]

47. Find a third-degree polynomial \( Q \) such that \( Q(1) = 2 \), \( Q'(1) = 7 \), \( Q''(1) = 14 \), and \( Q'''(1) = 18 \).

48. Differentiate the function.

\[
G(u) = \ln \sqrt{\frac{3u + 6}{3u - 6}}
\]

49. Evaluate.

\[
\lim_{x \to 1} \frac{x^{1000} - 1}{x - 1}
\]

50. If a ball is thrown vertically upward with a velocity of 200 ft/s, then its height after \( t \) seconds is \( s = 200t - 10t^2 \). What is the maximum height reached by the ball?

51. The curve with equation \( y^2 = 17x^4 - x^2 \) is called a kampyle of Eudoxus. Find an equation of the tangent line to this curve at the point (1, 4).

52. Use logarithmic differentiation to find the derivative of the function.

\[
f(x) = \sqrt[3]{\frac{x^2 + 1}{x^2 - 1}}
\]

53. Find the limit.

\[
\lim_{\theta \to 0} \frac{\sin (\sin \theta)}{\sec \theta}
\]