

b. Find the derivative of $N(t)$, and evaluate the derivative for $t = 4$.

$$\begin{aligned} N'(t) &= 200 \left[-\sin\left(\frac{\pi}{6}t\right) \right] \cdot \frac{\pi}{6} \\ &= -\frac{100\pi}{3} \sin\left(\frac{\pi}{6}t\right) \\ N'(4) &= -\frac{100\pi}{3} \sin\left(\frac{\pi}{6} \cdot 4\right) \\ &= -\frac{100\pi}{3} \sin\left(\frac{2\pi}{3}\right) \\ &= -\frac{100\pi}{3} \left(\frac{\sqrt{3}}{2}\right) \approx -91 \end{aligned}$$

At the end of August, the population is decreasing by about 91 geese per month.

9.2 EXERCISES

PRACTICE

In Exercises 1–28, find the derivative for each function.

1. $f(x) = 6 \cos(4x)$

2. $f(x) = 2 \tan(3x)$

3. $f(x) = -3 \sin^3 x$

4. $f(x) = 5 \cos^4 x$

5. $y = \ln x + \tan(2x)$

6. $y = e^x - \sin(5x)$

7. $y = x^2 \cos(8x)$

8. $y = 2x^3 \tan(6x)$

9. $f(x) = \sin x \cos x$

10. $f(x) = e^x \cos x$

11. $y = \frac{\sin x}{x}$

12. $y = \frac{\tan(2x)}{x}$

13. $y = \tan(e^{3x})$

14. $y = \sin(\ln x)$

15. $f(x) = \sqrt{\cos(5x)}$

16. $f(x) = \sqrt{\sin(4x)}$

17. $y = \sec(4x)$

18. $y = \cot \frac{1}{x}$

19. $y = \tan^2 x$

20. $y = \sec^2 x$

21. $y = \sin^2 x + \cos^2 x$

22. $y = \sec^2 x - \tan^2 x$

23. $y = 3e^{\cos x}$

24. $y = -6e^{\sin x}$

25. $f(x) = \ln(\sin x)$

26. $f(x) = \ln(\tan x)$

27. $y = \frac{\sin x}{1 + \cos x}$

28. $y = \frac{1 + \sin x}{\cos x}$

In Exercises 29–34, find $\frac{\partial f}{\partial x}$ and $\frac{\partial f}{\partial y}$ for each function.

29. $f(x, y) = 4x + \sin(xy)$

30. $f(x, y) = 3 \cos(xy) + x^2 y$

31. $f(x, y) = e^{xy} + y \sin x$

32. $f(x, y) = \cos(xy) + x \ln y$

33. $f(x, y) = 5x^3 \cos(3x + y)$

34. $f(x, y) = e^{-x} \sin(x + y)$

In Exercises 35–37, verify each of the formulas.

35. $\frac{d}{dx}[\cot x] = -\csc^2 x$

36. $\frac{d}{dx}[\sec x] = \sec x \tan x$

37. $\frac{d}{dx}[\csc x] = -\csc x \cot x$

38. Find the equation for the line tangent to the graph of $y = 3 \cos\left(\frac{\pi}{2}x\right)$ at the point where $x = 4$.

39. Find the equation for the line tangent to the graph of $y = 2 \sin\left(\frac{\pi}{3}x\right)$ at the point where $x = 2$.

APPLICATIONS

40. **Air quality:** On a typical summer day in southern California, the level of pollutants in the air can be estimated by $L(t) = 45.5 - 10.5 \cos(0.39t)$ PSI (Pollutant Standards Index), where t is the number of hours after 6:00 a.m. and $1 \leq t \leq 12$. Round your answers to the nearest thousandth.

- Find the level of pollutants at 2:00 p.m.
- Find the rate of change in the level of pollutants at noon.

41. **Marginal revenue:** The Mammoth Firewood Company cuts and sells firewood in a mountain resort. The number of cords of wood sold each month is estimated by $N(t) = 100 - 60 \sin\left(\frac{\pi}{6}t\right)$, where t is the time in months ($t = 1$ corresponds to January). Firewood sells for \$140 per cord.

- Find the revenue for May.
- Find the marginal revenue for September.
- Interpret the results in part b.

42. **Population:** The fox population in a midwestern state is estimated by

$$P(t) = 2400 + 400 \sin\left(\frac{\pi}{18}t\right), \text{ where } t \text{ is in months.}$$

- Find the number of foxes when $t = 15$.
- Find the rate of change in the fox population when $t = 24$.
- Interpret the result in part b.