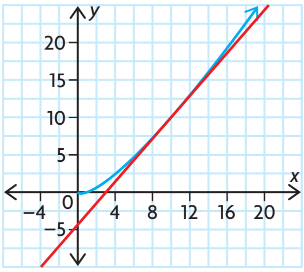
e. $\frac{\ln x + 1}{\ln 2}$

f. $\frac{4x + 1 - x\ln(3x^2)}{2x \ln 5(x + 1)^{\frac{3}{2}}}$

5. $y = 1.434x - 4.343$



6. $y = \log_a kx$

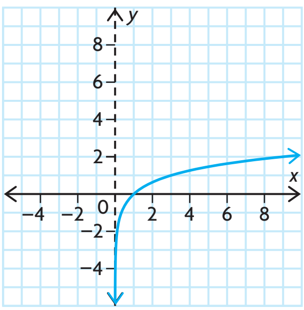
$$\frac{dy}{dx} = \frac{f'(x)}{f(x)\ln(a)}$$
$$= \frac{k}{kx\ln(a)}$$
$$= \frac{1}{x\ln(a)}$$

7. $y = 49.1x - 235.5$

8. Since the derivative is positive at $t = 15$, the distance is increasing at that point.

9. **a.** $y = 0.1x + 1.1$

b.



vertical asymptote at $x = 0$

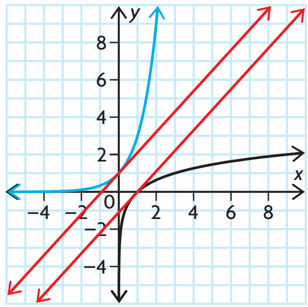
c. The tangent line will intersect this asymptote because it is defined for $x = 0$.

10. $D = \{x \in \mathbf{R} | x < -2 \text{ or } x > 2\}$; critical number at $x = 0$, $x = 2$, and $x = -2$; function is decreasing for $x < -2$ and increasing for $x > 2$

11. **a.** point of inflection at $x = 0$

b. $x = 0$ is a possible point of inflection. Since the graph is always concave up, there is no point of inflection.

12. The slope of $y = \log_3 x$ at $(1, 0)$ is $\frac{1}{\ln 3}$. Since $\ln 3 > 1$, the slope of $y = 3^x$ at $(0, 1)$ is greater than the slope of $y = \log_3 x$ at $(1, 0)$.



Logarithmic Differentiation, p. 582

1. **a.** $\sqrt{10}x^{\sqrt{10}-1}$

b. $15\sqrt{2}\,x^{3\sqrt{2}-1}$

c. $\pi t^{\pi - 1}$

d. $ex^{e-1} + e^x$

2. **a.** $\frac{2x^{\ln x}\ln x}{x}$

b. $\frac{(x+1)(x-3)^3}{(x+2)^3} \times \left(\frac{1}{x+1} + \frac{2}{x-3} - \frac{3}{x+2}\right)$

c. $\left(x^{\sqrt{x}}\right)\frac{\ln x + 2}{2\sqrt{x}}$

d. $\left(\frac{1}{t}\right)^t\left(\ln\frac{1}{t} - 1\right)$

3. **a.** $2e^e$

b. $e^2 + e \cdot 2^{e-1}$

c. $-\frac{4}{27}$

4. $y = 32(2\ln 2 + 1)(x - 128\ln 2 - 48)$

5. $-\frac{11}{36}$

6. $(e, e^{\frac{1}{e}})$

7. $(1, 1)$ and $(2, 4 + 4\ln 2)$

8. $\frac{32(\ln 4 + 1)^2}{\ln 4 + 2}$

9. $\frac{1}{8}$

10. $\left(\frac{x\sin x}{x^2 - 1}\right)^2 \times \left(\frac{2(\sin x + x\cos x)}{x\sin x} - \frac{4x}{x^2 - 1}\right)$

11. $x^{\cos x}\left(\sin x \ln x + \frac{\cos x}{x}\right)$

12. $y = x$

13. **a.** $v(t) = t^{\frac{1}{t}}\left(\frac{1 - \ln t}{t^2}\right)$,

$a(t) = \frac{t^{\frac{1}{t}}}{t^4}[1 - 2\ln t + (\ln t)^2 + 2t\ln t - 3t]$

b. $t = e$; $a(e) = -e^{\frac{1}{e} - 3}$

14. Using a calculator, $e^\pi \doteq 23.14$ and $\pi^e \doteq 22.46$. So, $e^\pi > \pi^e$.

Vector Appendix

Gaussian Elimination, pp. 588–590

1. **a.** $\left[\begin{array}{rrr|r} 1 & 2 & -1 & -1 \\ -1 & 3 & -2 & -1 \\ 0 & 3 & -2 & -3 \end{array}\right]$

b. $\left[\begin{array}{rrr|r} 2 & 0 & -1 & 1 \\ 0 & 2 & -1 & 16 \\ -3 & 1 & 0 & 10 \end{array}\right]$

c. $\left[\begin{array}{rrr|r} 2 & -1 & -1 & -2 \\ 1 & -1 & 4 & -1 \\ -1 & -1 & 0 & 13 \end{array}\right]$

2. Answers may vary. For example:

$\left[\begin{array}{rr|r} 1 & 1.5 & 0 \\ 0 & -5.5 & 1 \end{array}\right]$

$\left[\begin{array}{rr|r} 2 & 3 & 0 \\ 0 & -5.5 & 1 \end{array}\right]$

3. Answers may vary. For example:

$\left[\begin{array}{rrr|r} 2 & 1 & 6 & 0 \\ 0 & -2 & 1 & 0 \\ 0 & 0 & -37 & 4 \end{array}\right]$

4. **a.** Answers may vary. For example:

$\left[\begin{array}{rrr|r} 1 & 0 & -1 & -1 \\ 0 & -1 & 2 & 0 \\ 0 & 0 & -36 & 16 \end{array}\right]$

b. $x = -\frac{22}{9}, y = -\frac{8}{9}, z = -\frac{4}{9}$

5. **a.** $x - 2y = -1$
$2x - 3y = 1$
$2x - y = 0$

b. $-2x - z = 0$
$x - 2y = 4$
$y + 2z = -3$

c. $-z = 0$
$x = -2$
$y + z = 0$

6. **a.** $x = -\frac{9}{2}, y = -3$

b. $x = 13, y = 9, z = -6$

c. no solution

d. $x = -\frac{9}{4}, y = -4, z = -5$

e. $x = 2 - 3t + s, y = s,$
$z = t, s, t \in \mathbf{R}$
f. $x = 4, y = 8, z = -2$

7. **a.** It satisfies both properties of a matrix in row-echelon form.
1. All rows that consist entirely of zeros must be written at the bottom of the matrix.
2. In any two successive rows not consisting entirely of zeros, the first nonzero number in the lower row must occur further to the right that the first nonzero number in the row directly above.

b. A solution does not exist to this system, because the second row has no variables, but is still equal to a nonzero number, which is not possible.
c. Answers may vary. For example:
$$\left[\begin{array}{ccc|c} -1 & 1 & 1 & 3 \\ -2 & 2 & 2 & 3 \\ -1 & 1 & 1 & 3 \end{array}\right]$$

8. **a.** no; Answers may vary. For example:
$$\left[\begin{array}{ccc|c} -1 & 0 & 1 & 3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 2 & 1 \end{array}\right]$$
b. no; Answers may vary. For example:
$$\left[\begin{array}{ccc|c} 1 & 0 & 2 & -3 \\ 0 & 1 & -10 & 11 \\ 0 & 0 & 3 & 6 \end{array}\right]$$
c. no; Answers may vary. For example:
$$\left[\begin{array}{ccc|c} -1 & 2 & 1 & 0 \\ 0 & 0 & 1 & -6 \\ 0 & 0 & 0 & 0 \end{array}\right]$$
d. yes

9. **a.** **i.** $x = -\frac{5}{2}, y = 0, z = \frac{1}{2}$
ii. $x = -7, y = 31, z = 2$
iii. $x = 2t - 6, y = t, z = -6,$
$t \in \mathbf{R}$
iv. $x = -12 - 9t, y = -3 - 2t,$
$z = t, t \in \mathbf{R}$
b. **i.** The solution is the point at which the three planes meet.
ii. The solution is the point at which the three planes meet.
iii. The solution is the line at which the three planes meet.
iv. The solution is the line at which the three planes meet.

10. **a.** $x = -3, y = -4, z = 10$
The three planes meet at the point $(-3, -4, 10)$.
b. $x = -2t, y = t, z = t, t \in \mathbf{R}$
The three planes meet at this line.
c. $x = -1, y = 3t, z = t, t \in \mathbf{R}$
The three planes meet at this line.
d. $x = 0, y = 4, z = -2$
The three planes meet at the point $(0, 4, -2)$.
e. $x = -\frac{1}{2}, y = 2 - t, z = t, t \in \mathbf{R}$
The three planes meet at this line.
f. $x = 500, y = 1000, z = -1500$
The three planes meet at the point $(500, 1000, -1500)$.

11. $x = \frac{7a - 3c + 5b}{3},$
$y = \frac{3c - 4b - 5a}{3}, z = c - b - 2a$

12. $y = 2x^2 + 7x - 2$

13. $p = \frac{143}{9}, q = \frac{9}{121}, r = 33$

14. **a.** $a = -2$
b. $a = 1$
c. $a \neq -2$ or $a \neq 1$

Gauss-Jordan Method for Solving Systems of Equations, pp. 594–595

1. **a.** $\left[\begin{array}{cc|c} 1 & 0 & -7 \\ 0 & 1 & -2 \end{array}\right]$
b. $\left[\begin{array}{ccc|c} 1 & 0 & 0 & 3 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & 0 \end{array}\right]$
c. $\left[\begin{array}{ccc|c} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{array}\right]$
d. $\left[\begin{array}{ccc|c} 1 & 0 & 0 & 8 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 1 & -4 \end{array}\right]$

2. **a.** $(-7, -2)$
b. $(3, 2, 0)$
c. $(1, 1, 0)$
d. $(8, -1, -4)$

3. **a.** $x = -1, y = 10, z = 11$
b. $x = 3, y = 5, z = 7$
c. $x = 1, y = 2, z = -4$
d. $x = 0, y = 0, z = -1$
e. $x = -4, y = \frac{1}{3}, z = 0$
f. $x = \frac{1}{2}, y = \frac{1}{3}, z = \frac{1}{6}$

4. **a.** $x = -1, y = 2, z = 6$
b. $x = 38, y = 82, z = 14$

5. **a.** $k = 3$
b. $k \neq 3, k \in \mathbf{R}$
c. The matrix cannot be put in reduced row-echelon form.

6. **a.** Every homogeneous system has at least one solution, because (0, 0, 0) satisfies each equation.
b. $\left[\begin{array}{ccc|c} 1 & 0 & \frac{2}{3} & 0 \\ 0 & 1 & \frac{1}{3} & 0 \\ 0 & 0 & 0 & 0 \end{array}\right]$
The reduced row-echelon form shows that the intersection of these planes is a line that goes through the point $(0, 0, 0)$.
$x = -\frac{2}{3}t, y = -\frac{1}{3}t, z = t, t \in \mathbf{R}$

7. (2, 3, 6)