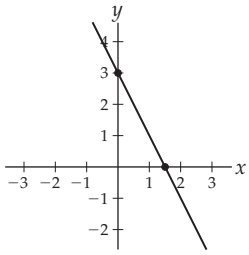
Chapter 0

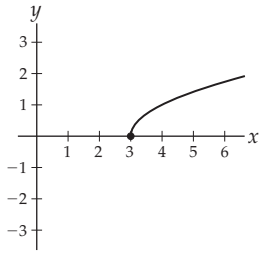
Skill Certification

1. $x^2 + x + 4$, if $x \neq 2$
3. $\dfrac{1}{(x+2)(x-1)}$
5. $2(x^2 + 1)$
7. $x^{-7/4} + x^{-5/3}$
9. x^2
11. $\sqrt{3} + 1$
13. $\left(-\infty, \frac{1}{2}\right) \cup (3, \infty)$
15. $(-\infty, 2) \cup (5, \infty)$
17. $\left(-\infty, \frac{1}{5}\right) \cup \left(\frac{3}{5}, \infty\right)$
19. Zero for $x = 1$ and $x = \frac{3}{2}$, undefined at $x = 0$
21. Zero for $x = 7$ and $x = -3$, defined everywhere
23. Zero for $x = 1 \pm \sqrt{2}$, undefined at $x = 1$
25. Zero for $x = -\ln 2$, defined everywhere
27. Zeroes for all integers x except $x = 0$, where the function is undefined
29. No zeroes, undefined at $x = 0$
31. $[-2, 0) \cup (0, \infty)$
33. $(-\infty, -2) \cup (-2, 3) \cup (3, \infty)$
35. $[0, 2]$
37. $(-\infty, \infty)$
39. $x \neq \frac{\pi}{6} + n\pi$, $x \neq \frac{5\pi}{6} + n\pi$, where n is an integer

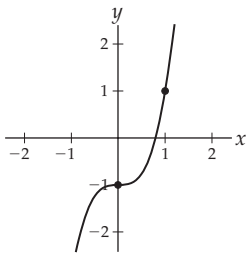
41.



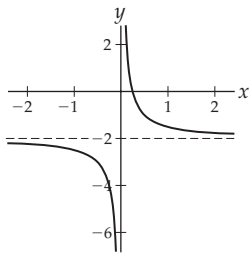
43.



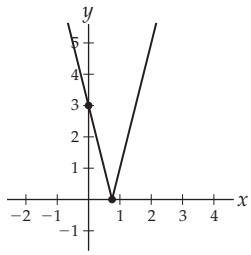
45.



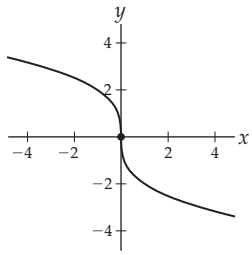
47.



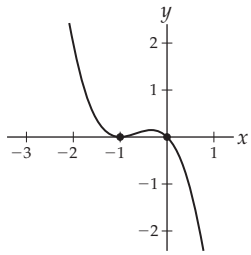
49.



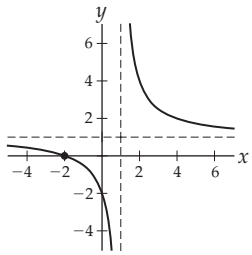
51.



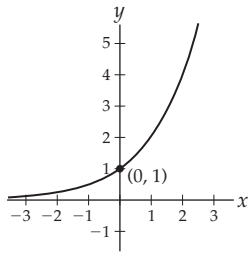
53.



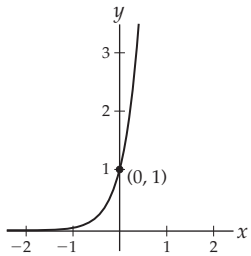
55.



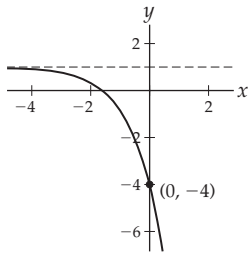
57.



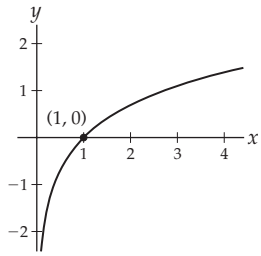
59.



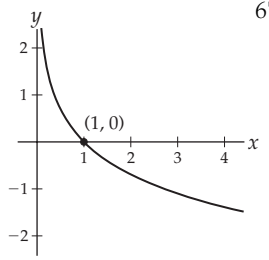
61.



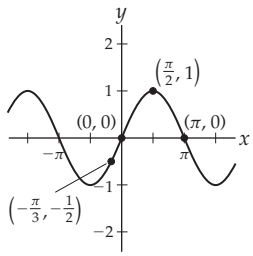
63.



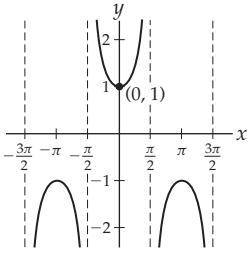
65.



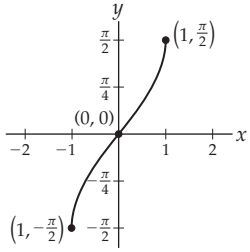
67.



69.



71.



Chapter 1

Skill Certification

1. ∞
3. DNE (∞ as $x \to 2^-$ and $-\infty$ as $x \to 2^+$)
5. DNE ($-\infty$ as $x \to 1^-$ and ∞ as $x \to 1^+$)
7. 0
9. $-\infty$
11. 0
13. $-\infty$
15. ∞
17. $-\infty$
19. ∞
21. -1
23. $\frac{3}{2}$
25. 0
27. e
29. 0
31. 0

Chapter 2

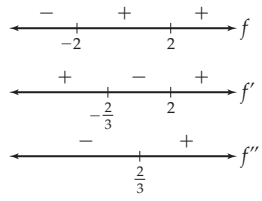
Skill Certification

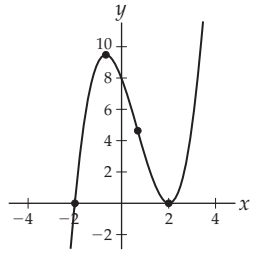
1. (a) $\lim_{h\to 0} \frac{(x+h)^2-x^2}{h} = \cdots = 2x$;
   (b) $\lim_{z\to x} \frac{z^2-x^2}{z-x} = \cdots = 2x$.
3. (a) $\lim_{h\to 0} \frac{\frac{1}{x+h}-\frac{1}{x}}{h} = \cdots = -\frac{1}{x^2}$;
   (b) $\lim_{z\to x} \frac{\frac{1}{z}-\frac{1}{x}}{z-x} = \cdots = -\frac{1}{x^2}$.
5. (a) $\lim_{h\to 0} \frac{\sqrt{x+h}-\sqrt{x}}{h} = \cdots = \frac{1}{2\sqrt{x}}$;
   (b) $\lim_{z\to x} \frac{\sqrt{z}-\sqrt{x}}{z-x} = \cdots = \frac{1}{2\sqrt{x}}$.
7. $f'(x) = -(x^4 - 5x^3 + 2)^{-2}(4x^3 - 15x^2)$
9. $f'(x) = -3(x\sqrt{2x-1})^{-4}(\sqrt{2x-1}+x\left(\frac{1}{2}\right)(2x-1)^{-1/2}(2))$
11. $f'(x) = -\frac{1}{2}x^{-3/2} + \frac{3}{2}x^{-5/2}$ (it helps if you simplify f before differentiating)
13. $f'(x) = \begin{cases} -1, & \text{if } x < 0 \\ \text{DNE}, & \text{if } x = 0 \\ 1, & \text{if } x > 0 \end{cases}$
15. $f'(x) = e^x \cos x + e^x \sin x$
17. $f'(x) = \frac{(\sin x)e^x - e^x(-\cos x)}{\sin^2 x}$
19. $f'(x) = \frac{2\sec^2 x}{\tan x}$
21. $f'(x) = \frac{1}{2}(\sin^{-1} x^2)^{-1/2}\frac{2x}{\sqrt{1-x^4}}$
23. $f'(x) = 2^{3x+1} + x(\ln 2)2^{3x+1}(3)$
25. $f'(x) = \frac{3}{2}\tanh^2(x^5)(\tanh^3(x^5))^{-1/2}\text{sech}^2(x^5)(5x^4)$
27. $f(x) = -32x + 4$
29. $f(x) = x^3 + \frac{1}{2}x^2 - 6$
31. $f(x) = 2e^{4x} + x + 1$
33. $f(x) = \frac{1}{4}\ln(1+4x) + 1$
35. $f(x) = \frac{1}{8}\ln(1+4x^2) + 1$
37. $\frac{dv}{dx} = -\frac{v}{x+6v}$
39. $\frac{dA}{dr} = 2\pi r$
41. $\frac{dy}{dt} = 3x^2 - kt^{k-1}$

Chapter 3

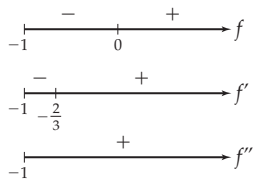
Skill Certification

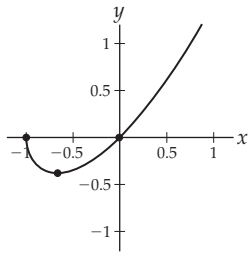
1. Positive on $(3, \infty)$ and negative on $(-\infty, -3) \cup (-3, 3)$; increasing on $(-\infty, -3) \cup (1, \infty)$ and decreasing on $(-3, 1)$; concave up on $(-1, \infty)$ and concave down on $(-\infty, -1)$.
3. Positive on $(-\infty, -3) \cup (1, \infty)$ and negative on $(-3, 1)$; increasing everywhere but $x = -3$ (where it is not defined); concave up on $(-\infty, -3)$ and concave down on $(-3, \infty)$.
5. Positive everywhere; increasing on $(0, \infty)$ and decreasing on $(-\infty, 0)$; concave up everywhere.
7. Positive on $(0, \infty)$ and negative on $(-\infty, 0)$; increasing on $(-1, \infty)$ and decreasing on $(-\infty, -1)$; concave up on $(-2, \infty)$ and concave down on $(-\infty, -2)$.
9. $x = 2$ is a local minimum and also a global minimum.
11. $x = -1$ is a local minimum and also a global minimum; $x = 1$ is a local maximum and also a global maximum.
13. $x = \frac{1}{e}$ is a local minimum and also a global minimum.
15. f has no local extrema and no global extrema.
17.



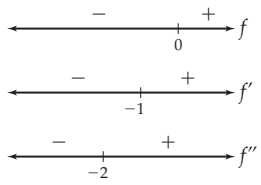


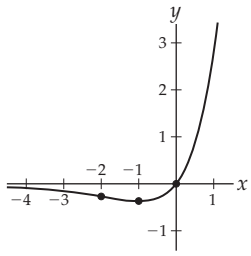
19.



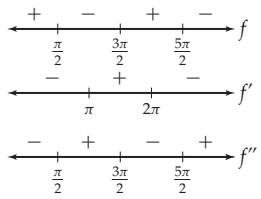


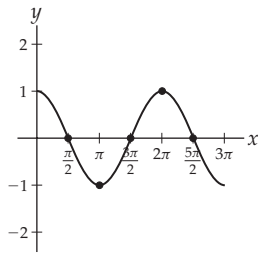
21.





23.





25. 0 27. ∞ 29. 1 31. e

Chapter 4

Skill Certification

1. $1+\frac{1}{4}+\frac{1}{9}+\cdots+\frac{1}{100}\approx 1.5498$
3. 1,758,051 5. $\frac{1}{3}$
7. $0+1+\sqrt{2}+\sqrt{3}\approx 4.146$
9. $\left(9-\frac{1}{4}\right)+\left(9-\frac{9}{4}\right)+\left(9-\frac{25}{4}\right)=\frac{73}{4}$
11. $(4(1)-1^2)+(4(2)-2^2)+(4(2)-2^2)=11$
13. $\lim_{n\to\infty}\sum_{k=1}^{n}\left(2\left(3+\frac{2k}{n}\right)+4\right)\left(\frac{2}{n}\right)=24$
15. $\lim_{n\to\infty}\sum_{k=1}^{n}\left(4-\left(-2+\frac{5k}{n}\right)^2\right)\left(\frac{5}{n}\right)=\frac{25}{3}$
17. $\frac{3}{5}x^5-\frac{1}{4}x^4+2x+C$ 19. $e^x-\frac{1}{4}e^{4x}+C$
21. $\frac{3}{4}\ln(1+4x)+C$ 23. $x^2 3^x+C$
25. $3\tanh x+C$ 27. $\frac{4}{3}$
29. 0 31. $\frac{16}{3}$ 33. 0
35. 16 37. $\frac{1}{\pi}$ 39. x^3
41. 0 43. 0 45. $-\sin^3 x$

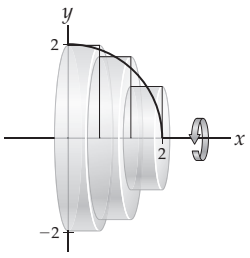
Chapter 5

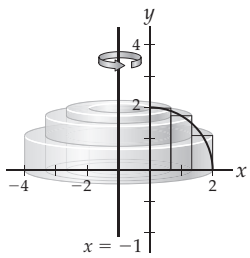
Skill Certification

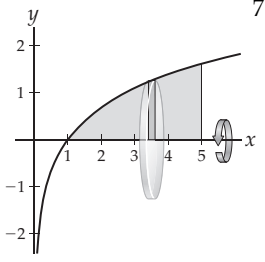
1. $\sin x-\sin^3 x+\frac{3}{5}\sin^5 x-\frac{1}{7}\sin^7 x+C$
3. $x\sec x-\ln|\sec x+\tan x|+C$
5. $-\frac{\ln 2x}{x}-\frac{1}{x}+C$
7. $\frac{1}{5}\cot^5 x+\frac{1}{3}\cot^3 x-\cot x-x+C$
9. $8\pi x^2-\frac{4}{7}\pi x^{7/2}+C$ 11. $\frac{4}{3}\ln 4-1$
13. $-\frac{2}{3}\ln|1-x\sqrt{x}|+C$
15. $\frac{1}{2}(x\sin(\ln x)-x\cos(\ln x))+C$
17. $x\ln\left(\frac{x^3}{x^2+1}\right)-2x-\frac{1}{2}\ln|2x+1|+C$
19. $x(\ln x)^3-3x(\ln x)^2+6x\ln x-6x+C$
21. $\frac{1}{5}\sec^5 x-\frac{1}{3}\sec^3 x+C$
23. $\frac{49}{5}2^{3/2}-\frac{82}{5}$
25. $-\frac{1}{3}\ln|\csc 3x+\cot 3x|+C$
27. $e-e^{1/3}$
29. $\frac{2}{11}(x+5)^{11/2}-\frac{10}{9}(x+5)^{9/2}+C$
31. $\frac{1}{3}\left(\ln|x|-\frac{1}{x}-\frac{1}{2}\ln(x^2+3)-\frac{1}{\sqrt{3}}\tan^{-1}\frac{x}{\sqrt{3}}\right)+C$
33. $-\frac{1}{2}e^{-x^2}(x^2+1)+C$
35. $\frac{1}{1+\ln 2}(2e)^x+C$
37. $3\ln|x-1|+2\ln|x^2+2x+3|+C$
39. $\frac{x}{9\sqrt{9-4x^2}}+C$
41. $\tan^{-1}x(\ln(\tan^{-1}x)-1)+C$
43. $\frac{1}{2}\tanh x^2+C$ 45. $\frac{1}{2}(\sinh^{-1}x)^2+C$
47. $8-4\tan^{-1}4$ 49. $\frac{\sqrt{3}}{2}+\frac{\pi}{12}$
51. $-e^{-3}$ 53. 6
55. Diverges to $-\infty$ 57. Diverges to ∞
59. $\frac{2}{3}(e^{-1/9}+e^{-1/9}+e^1)\approx 1.438$
61. $\frac{1}{6}\left(\sqrt{1}+4\sqrt{1+\frac{1}{8}}+2\sqrt{1+1}+4\sqrt{1+\frac{27}{8}}+2\sqrt{1+8}+4\sqrt{1+\frac{5^3}{8}}+\sqrt{1+\frac{6^3}{8}}\right)\approx 7.3398$

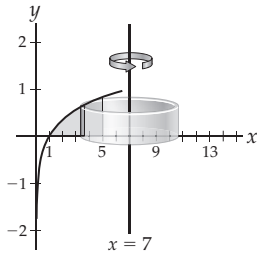
Chapter 6

Skill Certification

1. 

3. 

5. 

7. 

9. (a) With washers, $\pi \int_0^2 (16 - x^4)\, dx = \frac{128}{5}\pi$; with shells, $2\pi \int_0^4 y\sqrt{y}\, dy = \frac{128}{5}\pi$. (b) With disks, $\pi \int_0^4 (\sqrt{y})^2\, dy = 8\pi$; with shells, $2\pi \int_0^2 x(4 - x^2)\, dx = 8\pi$.

11. (a) With washers, $\pi \int_0^1 ((\sqrt[3]{y})^2 - (y^2)^2)\, dy = \frac{2\pi}{5}$; with shells, $2\pi \int_0^1 x(\sqrt{x} - x^3)\, dx = \frac{2\pi}{5}$. (b) With washers, $\pi \int_0^1 ((2 - y^2)^2 - (2 - \sqrt[3]{y})^2)\, dy = \frac{19\pi}{15}$; with shells, $2\pi \int_0^1 (2 - x)(\sqrt{x} - x^3)\, dx = \frac{19\pi}{15}$.

13. $4\pi \int_0^1 \sin(\pi x)\sqrt{1 + \pi^2 \cos^2 \pi x}\, dx = 4\sqrt{1+\pi^2} - \frac{2}{\pi} \ln\left(\frac{\sqrt{1+\pi^2} - \pi}{\sqrt{1+\pi^2} + \pi}\right)$

15. The two graphs meet at $\frac{9-\sqrt{17}}{2}$, and the centroid is at approximately (1.5166, 1.7918).

17. $\int_0^6 62.4(20)(6 - y)\, dy = 22,464$ pounds

19. $y = e^{5x}$

21. $y = \frac{1}{5 - 4e^{-2x}}$

Chapter 7

Skill Certification

1. Monotonically increasing, bounded below, diverges to infinity

3. Monotonically decreasing, bounded, converges to $\frac{2}{3}$

5. Monotonically increasing, bounded, converges to 1

7. Monotonically decreasing, bounded, converges to 0

9. (a) $\frac{1}{12}, \frac{2}{15}, \frac{1}{6}, \frac{4}{21}, \frac{5}{24}$; (b) $\frac{1}{3} - \frac{1}{k+4}$; (c) $\frac{1}{3}$

11. (a) $\frac{1}{\ln 2} - \frac{1}{2\ln 3}, \frac{1}{\ln 2} - \frac{1}{4\ln 4}, \frac{1}{\ln 2} - \frac{1}{8\ln 5}, \frac{1}{\ln 2} - \frac{1}{16\ln 6}, \frac{1}{\ln 2} - \frac{1}{32\ln 7}$; (b) $\frac{1}{\ln 2} - \frac{1}{2^{k+1}\ln(k+3)}$; (c) $\frac{1}{\ln 2}$

13. $\frac{1}{486}$

15. The series diverges by the divergence test.

17. The series diverges by the divergence test.

19. The series diverges by the divergence test.

21. The series converges by the ratio test.

23. Compare the series to the divergent series $\sum_{k=1}^{\infty} \frac{1}{k}$ using the limit comparison test. The given series diverges.

25. The series diverges by the divergence test.

27. Compare the series to the divergent series $\sum_{k=1}^{\infty} \frac{1}{k}$ using the limit comparison test. The given series diverges.

29. Compare the series to the convergent geometric series $\sum_{k=1}^{\infty} \frac{1}{2^k}$ using the limit comparison test. The given series converges.

31. The series diverges by the divergence test.

33. The series converges absolutely by the ratio test for absolute convergence.

35. The series diverges by the divergence test.

37. The series converges absolutely by the ratio test for absolute convergence.

39. The series converges by the alternating series test. When we compare the series $\sum_{k=1}^{\infty} \frac{\sqrt{k}}{3k-1}$ to the divergent p-series, $\sum_{k=1}^{\infty} \frac{1}{\sqrt{k}}$ using the limit comparison test, we see that the series of absolute values diverges, so the given series converges conditionally.

Chapter 8

Skill Certification

1. The interval of convergence is $[-1, 1)$. The series converges conditionally when $x = -1$.

3. The interval of convergence is $(2, 4)$.

5. The interval of convergence is $(-\infty, \infty)$.

7. The interval of convergence is $(0, 4]$. The series converges conditionally when $x = 4$.

9. $x - \frac{1}{3}x^3$

11. x^2

13. $1 + \frac{3}{2}x^2$

15. $\sum_{k=0}^{\infty} \frac{(-1)^k}{(2k+1)!}x^{2k+1}$

17. $\sum_{k=0}^{\infty} \frac{1}{k!}x^k$

19. $\sum_{k=0}^{\infty} x^k$

21. $\sum_{k=0}^{\infty}(-1)^k(x-1)^k$

23. $1 + \frac{1}{2}(x-1) + \sum_{k=2}^{\infty}(-1)^k \frac{1\cdot 3\cdot 5\cdots(2k-3)}{2^k k!}(x-1)^k$

25. 0

27. 0

29. $g(x) = \sum_{k=0}^{\infty} \frac{1}{k!}x^{k+2}$, $g'(x) = \sum_{k=0}^{\infty} \frac{k+2}{k!}x^{k+1}$, $\int g(x)\,dx = \sum_{k=0}^{\infty} \frac{1}{k!(k+3)}x^{k+3} + C$

31. $\frac{1}{1+x} = \sum_{k=0}^{\infty}(-1)^k x^k$, $\ln(1+x) = \sum_{k=0}^{\infty} \frac{(-1)^k}{k+1}x^{k+1}$, $\int \ln(1+x)\,dx = \sum_{k=0}^{\infty} \frac{(-1)^k}{(k+1)(k+2)}x^{k+2} + C$, $\int_0^2 \ln(1+x)\,dx = \sum_{k=0}^{\infty} \frac{(-1)^k}{(k+1)(k+2)}2^{k+2}$

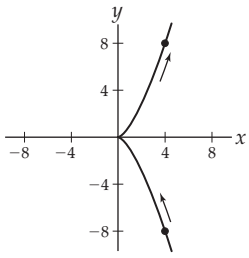
33. $\sum_{k=0}^{4} \frac{(-1)^k}{2^k k!}$ approximates the $e^{-1/2}$ to within 0.001, $\sum_{k=0}^{7} \frac{(-1)^k}{2^k k!}$ would give an approximation within 10^{-6}.

35. $\sum_{k=0}^{12} \frac{(-1)^k 3^{4k+3}}{(4k+3)(2k+1)!}$ approximates the integral to within 0.001 of its value, $\sum_{k=0}^{15} \frac{(-1)^k 3^{4k+3}}{(4k+3)(2k+1)!}$ would give an approximation within 10^{-6}.

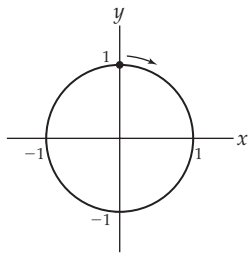
Chapter 9

Skill Certification

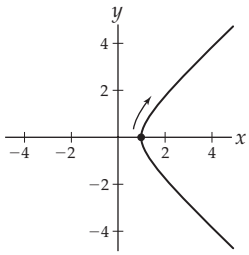
1.



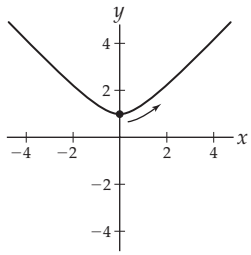
3.



5.



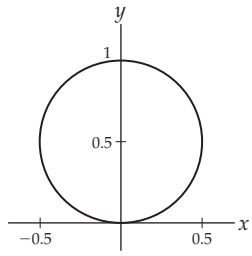
7.



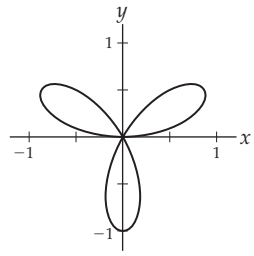
9. $\frac{2}{27}(80\sqrt{10} - 8)$

11. $2k\pi$

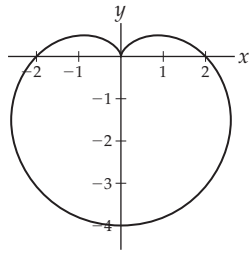
13.



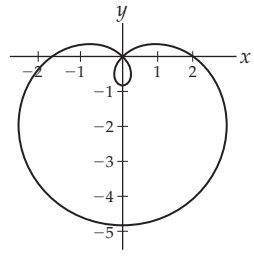
15.



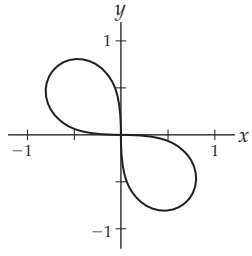
17.



19.



21.



23. $2\pi a$

25. πa

27. 8

29. $\frac{2\sqrt{3}}{3}$

31. πa^2

33. $\frac{\pi}{8}$

35. $\frac{3\pi}{2}$

37. $\frac{1}{2}$

39. $1 - \frac{\sqrt{2}}{2}$

Chapter 10

Skill Certification

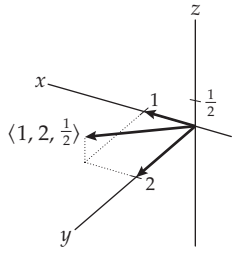
1. $\sqrt{34}$

3. $\sqrt{21}$

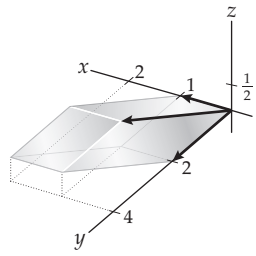
5. 36

7. $(x-2)^2 + (y-7)^2 + \left(z + \frac{3}{2}\right)^2 = \frac{21}{4}$

9.



11.



13. 2

15. 0

17. 90°

19. Both diagonals are $\sqrt{5}$ units.

21. $\langle 0, 0, 1\rangle$

23. The faces determined by $\mathbf{u}$ and $\mathbf{v}$ have area 2. The faces determined by $\mathbf{v}$ and $\mathbf{w}$ have area $\sqrt{5}$. The faces determined by $\mathbf{u}$ and $\mathbf{w}$ have area $\frac{\sqrt{17}}{2}$.

25. $\sqrt{21}$ 27. -14

29. $\theta = \cos^{-1}\left(-\frac{14}{273}\right) \approx 147.92^\circ$

31. $\sqrt{32}$ 33. $\frac{1}{\sqrt{77}}\langle 5, -4, -6\rangle$

35. The faces determined by $\mathbf{u}$ and $\mathbf{v}$ have area $\sqrt{77}$. The faces determined by $\mathbf{v}$ and $\mathbf{w}$ have area $\sqrt{302}$. The faces determined by $\mathbf{u}$ and $\mathbf{w}$ have area $3\sqrt{62}$.

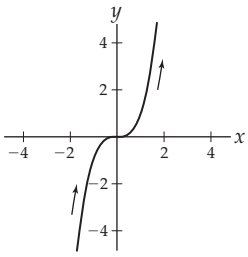
37. $\mathbf{r}(t) = \langle 2, -3, 5\rangle + t\langle -3, 3, 2\rangle$

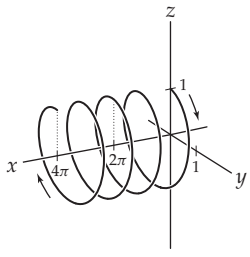
39. $23x + 13y + 15z = 82$

41. $\sqrt{\frac{221}{7}}$ 43. $\left\langle \frac{29}{7}, -\frac{18}{7}, -\frac{12}{7}\right\rangle$

Chapter 11

Skill Certification

1. 

3. 

5. $\left\langle -\frac{1}{9}, 6\right\rangle$ 7. $\langle 1, 0, e\rangle$

9. $\mathbf{v}(t) = \langle 1, 2, 3\rangle$, $\mathbf{a}(t) = \langle 0, 0, 0\rangle$

11. $\mathbf{v}(t) = \langle -2\sin 2t, 3\cos 3t\rangle$,
$\mathbf{a}(t) = \langle -4\cos 2t, -9\sin 3t\rangle$

13. $\frac{1}{\sqrt{145}}\langle 1, 12\rangle$ 15. $\left\langle \frac{\alpha\beta}{|\alpha\beta|}, 0\right\rangle$

17. $\frac{1}{\sqrt{5+4\pi^2}}\langle 1, -2\pi, -2\rangle$ 19. $\frac{1}{\sqrt{145}}\langle -12, 1\rangle$

21. $\langle 0, -1\rangle$

23. $\frac{1}{\sqrt{(5+4\pi^2)(4\pi^4+17\pi^2+20)}}\langle -2\pi, -2(5+2\pi^2),$
$\pi(9+4\pi^2)\rangle$

25. $\langle 0, 0, 1\rangle$, $z = 0$ 27. $\langle 0, 0, -1\rangle$, $z = 0$

29. $\frac{1}{(5+4\pi^2)\sqrt{4\pi^4+17\pi^2+20}}\langle -8\pi^4 - 26\pi^2 - 20,$
$-4\pi^3 - 5\pi, -8\pi^2 - 10\rangle$,
$(8\pi^4 + 26\pi^2 + 20)(x - \pi) + (4\pi^3 + 5\pi)y +$
$(8\pi^2 + 10)(z + 2\pi) = 0$

31. $(x + 143)^2 + \left(y - \frac{241}{12}\right)^2 = \frac{145^3}{144}$

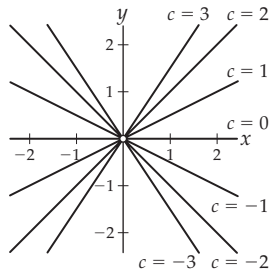
33. $x^2 + y^2 = \alpha^2$

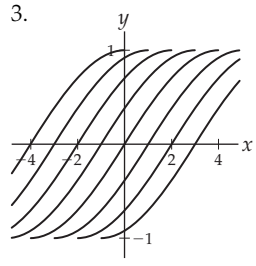
35. Center $\langle \pi, 0, -2\pi\rangle + \frac{5+4\pi^2}{2(4\pi^4+17\pi^2+20)}$
$\langle -2\pi, -2(5+2\pi^2), \pi(9+\pi^2)\rangle$; radius
$\frac{(5+4\pi^2)^{3/2}}{2\sqrt{4\pi^4+17\pi^2+20}}$.

37. $x^2 + \left(y - \frac{1}{2}\right)^2 = \frac{1}{4}$ 39. $(x+2)^2 + (y-3)^2 = 8$

Chapter 12

Skill Certification

1. 

3. 

5. $-\frac{5}{3}$ 7. 0

9. 0 11. -1

13. All points in $\mathbb{R}^2$ except where $y = x$.

15. All points in $\mathbb{R}^2$ where $x > 0$ and $y > 0$ or where $x < 0$ and $y < 0$.

17. All points in $\mathbb{R}^3$ except where $x - 2y + 3z = 0$.

19. $f_x(x, y) = \frac{y^2-2xy-x^2}{(x^2+y^2)^2}$, $f_y(x, y) = \frac{x^2-2xy-y^2}{(x^2+y^2)^2}$,
$f_{xx}(x, y) = \frac{2x^3-6xy^2+6x^2y-2y^3}{(x^2+y^2)^3}$,
$f_{yy}(x, y) = \frac{2y^3-6x^2y+6xy^2-2x^3}{(x^2+y^2)^3}$,
$f_{xy}(x, y) = f_{yx}(x, y) = \frac{-2y^3+6xy^2+6x^2y-2x^3}{(x^2+y^2)^3}$

21. $f_x(x, y) = (2x^2y + y)e^{x^2}$, $f_y(x, y) = xe^{x^2}$,
$f_{xx}(x, y) = (4x^3y + 6xy)e^{x^2}$, $f_{yy}(x, y) = 0$,
$f_{xy}(x, y) = f_{yx}(x, y) = (2x^2 + 1)e^{x^2}$

23. $f_x(x, y, z) = z^2e^y$, $f_y(x, y, z) = xz^2e^y$, $f_z(x, y, z) = 2xze^y$,
$f_{xx}(x, y, z) = 0$, $f_{yy}(x, y, z) = xz^2e^y$, $f_{zz}(x, y, z) = 2xe^y$,
$f_{xy}(x, y, z) = f_{yx}(x, y, z) = z^2e^y$,
$f_{yz}(x, y, z) = f_{zy}(x, y, z) = 2xze^y$,
$f_{xz}(x, y, z) = f_{zx}(x, y, z) = 2ze^y$

25. $-\frac{9}{8\sqrt{13}}$ 27. $\frac{11}{25\sqrt{13}}$ 29. 0

31. $\nabla f(x, y) = \left\langle -\frac{y}{x^2}, \frac{1}{x} \right\rangle$, $\nabla f(4, 3) = \left\langle -\frac{3}{16}, \frac{1}{4} \right\rangle$

33. $\nabla f(x, y) = \langle \sin y, x \cos y \rangle$, $\nabla f\left(3, \frac{\pi}{2}\right) = \langle 1, 0 \rangle$

35. $\nabla f(x, y, z) = \left\langle \frac{2xy}{z}, \frac{x^2}{z}, -\frac{x^2 y}{z^2} \right\rangle$, $\nabla f(0, 3, -1) = \langle 0, 0, 0 \rangle$

37. f has a local minimum at $\left(0, -\frac{1}{2}\right)$.

39. f has saddle points at $(0, 0)$ and $(4, -2)$, a local minimum at $(4, 0)$, and a local maximum at $(0, -2)$.

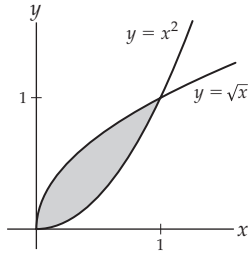
Chapter 13

Skill Certification

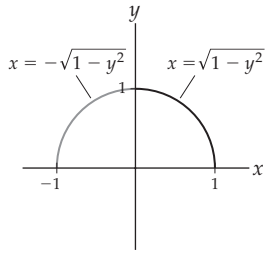
1. 36

3. 36

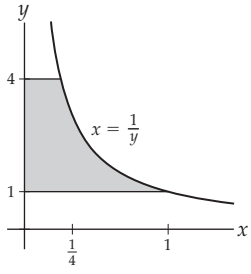
5. $\frac{3}{110}$



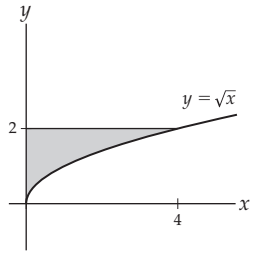
7. 0



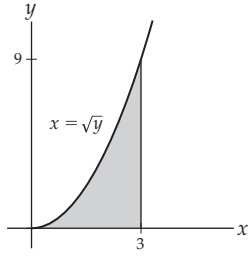
9. $\frac{15}{64}$



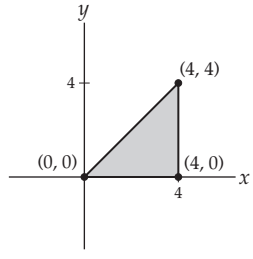
11. $\frac{1}{2}(1 - \cos 4)$



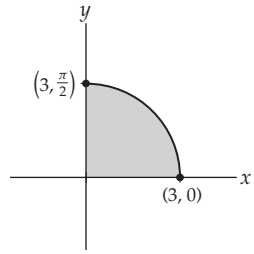
13. $\frac{1}{3} \ln 28$



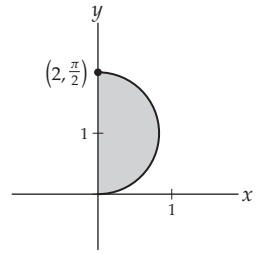
15. $8(e - 1)$



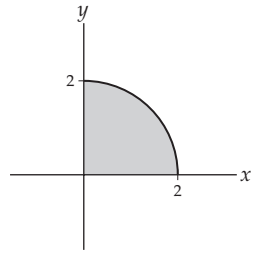
17. $\frac{9}{2}\pi$



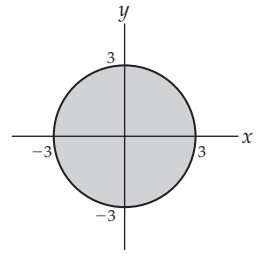
19. $\frac{3}{4}\pi$



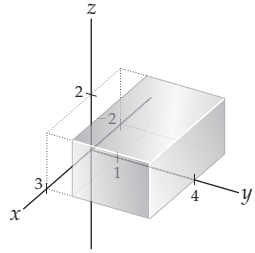
21. $\frac{1}{4}(e^4 - 1)\pi$



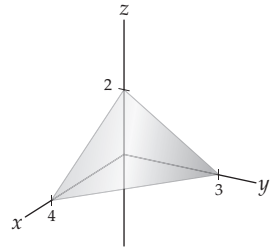
23. 0



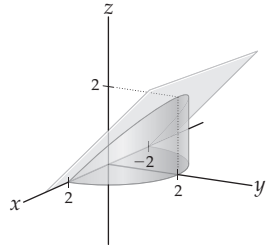
25. 30



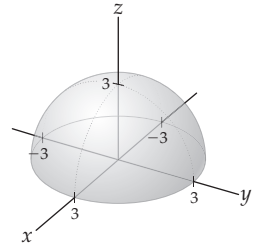
27. 4



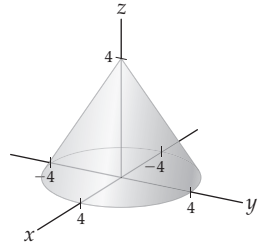
29. $\frac{16}{3}$



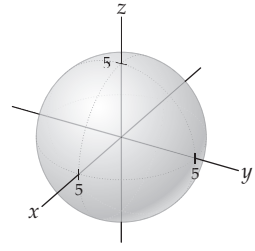
31. 18π



33. $\frac{64}{3}\pi$



35. $\frac{500}{3}\pi$



Chapter 14

Skill Certification

1. $f(x, y) = x^3y^2$
3. $g(x, y) = xze^{y^2}$
5. The vector field is not conservative.
7. The vector field is conservative and $f(x, y) = ye^{xy^2}$ is a potential function.
9. The vector field is not conservative.
11. 12
13. 0
15. $3e - 3$
17. $3\sqrt{29}$
19. $(32 - 8\sqrt{7})\pi$
21. 0
23. $\frac{128}{15}$
25. div $\mathbf{F} = -2$, curl $\mathbf{F} = -3\mathbf{k}$
27. div $\mathbf{F} = 3$, curl $\mathbf{F} = \langle 1, 1, 1 \rangle$
29. 0
31. 0
33. -92
35. 0
37. 0
39. $\frac{609}{4}\pi$