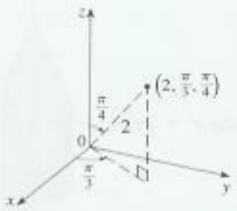
(b) $\left(\frac{1}{2}\sqrt{2}, \frac{1}{2}\sqrt{6}, \sqrt{2}\right)$



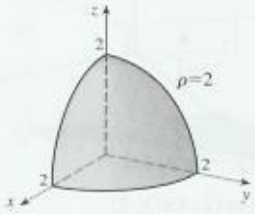
3. (a) $(4, \pi/3, \pi/6)$ (b) $(\sqrt{2}, 3\pi/2, 3\pi/4)$

5. Semicone

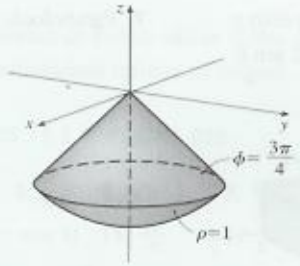
7. Esfera, raio $\frac{1}{2}$, centro $(0, \frac{1}{2}, 0)$

9. (a) $\cos^2\phi = \operatorname{sen}^2\phi$ (b) $\rho^2(\operatorname{sen}^2\phi \cos^2\theta + \cos^2\phi) = 9$

11.

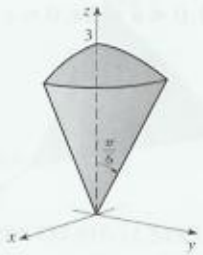


13.



15. $0 \le \phi \le \pi/4, 0 \le \rho \le \cos\phi$

17. $(9\pi/4)(2 - \sqrt{3})$



19. $\int_0^{\pi/2}\int_0^3\int_0^2 f(r\cos\theta, r\operatorname{sen}\theta, z)\, r\, dz\, dr\, d\theta$

21. $312\,500\pi/7$ **23.** $15\pi/16$ **25.** $1562\pi/15$

27. $(\sqrt{3} - 1)\pi a^3/3$ **29.** (a) 10π (b) $(0, 0, 2{,}1)$

31. $\left(0, \frac{525}{296}, 0\right)$

33. (a) $\left(0, 0, \frac{3}{8}a\right)$ (b) $4Kpa^5/15$

35. $(2\pi/3)[1 - (1/\sqrt{2})], (0, 0, 3/[8(2 - \sqrt{2})])$

37. $5\pi/6$ **39.** $(4\sqrt{2} - 5)/15$

41.

43. $136\pi/99$

EXERCÍCIOS 15.9 ■ PÁGINA 968

1. 16 **3.** 0 **5.** $2uvw$

7. O paralelogramo com vértices $(0, 0), (6, 3), (12, 1), (6, -2)$

9. A região limitada pela reta $y = 1$, pelo eixo y e por $y = \sqrt{x}$

11. -3 **13.** 6π **15.** $2 \ln 3$

17. (a) $\frac{4}{3}\pi abc$ (b) $1\,083 \times 10^{12}$ km^3

19. $\frac{8}{5}\ln 8$ **21.** $\frac{3}{2}\operatorname{sen} 1$ **23.** $e - e^{-1}$

CAPÍTULO 15 REVISÃO ■ PÁGINA 969

Testes Verdadeiro-Falso

1. Verdadeiro **3.** Verdadeiro **5.** Verdadeiro **7.** Falso

Exercícios

1. $\approx 64{,}0$ **3.** $4e^2 - 4e + 3$ **5.** $\frac{1}{2}\operatorname{sen} 1$ **7.** $\frac{2}{3}$

9. $\int_0^{\pi}\int_2^4 f(r\cos\theta, r\operatorname{sen}\theta)\, r\, dr\, d\theta$

11. A região dentro do laço da rosácea de quatro pétalas $r = \operatorname{sen} 2\theta$ no primeiro quadrante

13. $\frac{1}{2}\operatorname{sen} 1$ **15.** $\frac{1}{2}e^6 - \frac{7}{2}$ **17.** $\frac{1}{4}\ln 2$ **19.** 8

21. $81\pi/5$ **23.** 40,5 **25.** $\pi/96$ **27.** $\frac{64}{15}$

29. 176 **31.** $\frac{2}{3}$ **33.** $2ma^3/9$

35. (a) $\frac{1}{4}$ (b) $\left(\frac{1}{3}, \frac{8}{15}\right)$

(c) $I_x = \frac{1}{12}, Iy = \frac{1}{24}; \bar{y} = 1/\sqrt{3}, \bar{x} = 1/\sqrt{6}$

37. $(0, 0, h/4)$

39. 97,2 **41.** 0,0512

43. (a) $\frac{1}{15}$ (b) $\frac{1}{3}$ (c) $\frac{1}{45}$

45. $\int_0^1\int_0^{1-z}\int_{-\sqrt{y}}^{\sqrt{y}} f(x, y, z)\, dx dy\, dz$ **47.** $-\ln 2$ **49.** 0

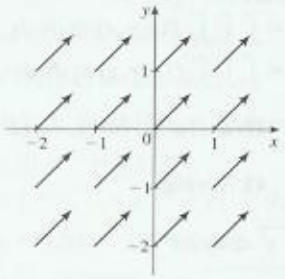
PROBLEMAS QUENTES ■ PÁGINA 972

1. 30 **3.** $\frac{1}{2}\operatorname{sen} 1$ **7.** (b) 0,90

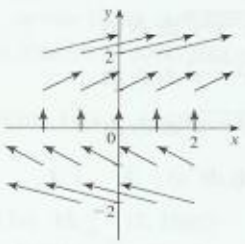
CAPÍTULO 16

EXERCÍCIOS 16.1 ■ PÁGINA 980

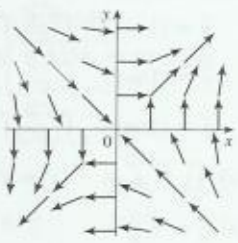
1.



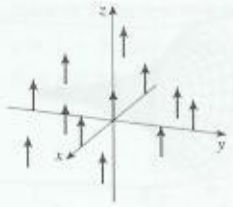
3.

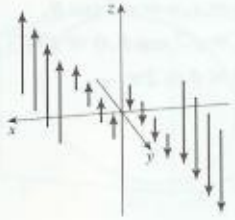


5.



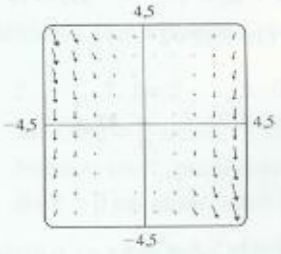
7.





11. II **13.** I **15.** IV **17.** III

19. A reta $y = 2x$

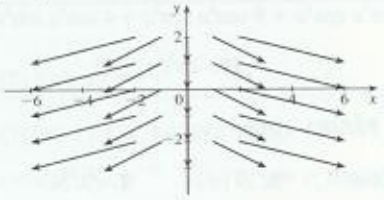


21. $\nabla f(x, y) = \dfrac{1}{x + 2y}\,\mathbf{i} + \dfrac{2}{x + 2y}\,\mathbf{j}$

23. $\nabla f(x, y) = \dfrac{x}{\sqrt{x^2 + y^2 + z^2}}\,\mathbf{i} + \dfrac{y}{\sqrt{x^2 + y^2 + z^2}}\,\mathbf{j}$

$+ \dfrac{z}{\sqrt{x^2 + y^2 + z^2}}\,\mathbf{k}$

25. $\nabla f(x, y) = 2x\,\mathbf{i} - \mathbf{j}$



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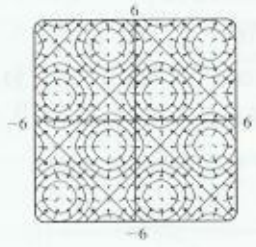
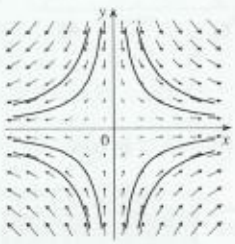


29. III **31.** II **33.** (2,04, 1,03)

35. (b) $y = 1/x, x > 0$



$y = C/x$

EXERCÍCIOS 16.2 ■ PÁGINA 990

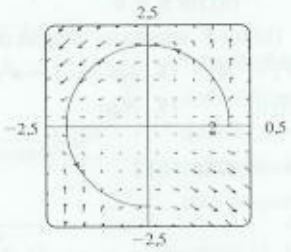
1. $\frac{1}{54}(145^{3/2} - 1)$ **3.** 1638,4 **5.** $\frac{243}{8}$ **7.** $\frac{17}{3}$ **9.** 320

11. $\frac{1}{12}\sqrt{14}\,(e^6 - 1)$ **13.** $\frac{1}{5}$ **15.** $\frac{97}{3}$

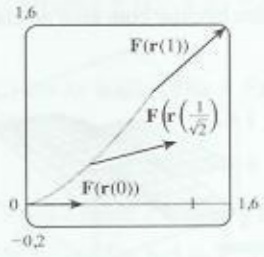
17. (a) Positivo (b) Negativo

19. 45 **21.** $\frac{6}{5} - \cos 1 - \operatorname{sen} 1$ **23.** 1,9633 **25.** 15,0074

27. $3\pi + \frac{2}{3}$



29. (a) $\frac{11}{8} - 1/e$ (b)



31. $\frac{172\,704}{5\,632\,705}\sqrt{2}(1 - e^{-14\pi})$ **33.** $2\pi k, (4/\pi, 0)$

35. (a) $\bar{x} = (1/m)\int_C x\rho(x, y, z)\,ds$,
$\bar{y} = (1/m)\int_C y\rho(x, y, z)\,ds$,
$\bar{z} = (1/m)\int_C z\rho(x, y, z)\,ds$, onde $m = \int_C \rho(x, y, z)\,ds$
(b) $(0, 0, 3\pi)$

37. $I_x = k\left(\frac{1}{2}\pi - \frac{4}{3}\right), I_y = k\left(\frac{1}{2}\pi - \frac{2}{3}\right)$

39. $2\pi^2$ **41.** 26 **43.** $1{,}67 \times 10^4$ pés-lb

45. (b) Sim **47.** ≈22 J

EXERCÍCIOS 16.3 ■ PÁGINA 999

1. 40 **3.** $f(x, y) = x^2 - 3xy + 2y^2 - 8y + K$

5. $f(x, y) = e^x \operatorname{sen} y + K$ **7.** $f(x, y) = ye^x + x \operatorname{sen} y + K$

9. $f(x, y) = x \ln y + x^2y^3 + K$

11. (b) 16 **13.** (a) $f(x, y) = \frac{1}{2}x^2y^2$ (b) 2

15. (a) $f(x, y, z) = xyz + z^2$ (b) 77

17. (a) $f(x, y, z) = xy^2 \cos z$ (b) 0

19. 25 sen 1 − 1 **21.** 30 **23.** Não **25.** Conservativo

29. (a) Sim (b) Sim (c) Sim

31. (a) Sim (b) Sim (c) Não

EXERCÍCIOS 16.4 ■ PÁGINA 1006

1. 8π **3.** $\frac{2}{3}$ **5.** $e - 1$ **7.** $\frac{1}{3}$ **9.** -24π **11.** $\frac{4}{3} - 2\pi$

13. $\frac{625}{2}\pi$ **15.** $-8e + 48e^{-1}$ **17.** $-\frac{1}{12}$ **19.** 3π **21.** (c) $\frac{9}{2}$

23. $(4a/3\pi, 4a/3\pi)$ se a região for a parte do disco $x^2 + y^2 = a^2$ no primeiro quadrante

EXERCÍCIOS 16.5 ■ PÁGINA 1013

1. (a) $-x^2\mathbf{i} + 3xy\,\mathbf{j} - xz\,\mathbf{k}$ (b) yz

3. (a) $\mathbf{0}$ (b) 1

5. (a) $\mathbf{0}$ (b) $2/\sqrt{x^2 + y^2 + z^2}$

7. (a) $\langle 1/y, -1/x, 1/x\rangle$ (b) $1/x + 1/y + 1/z$

9. (a) Negativo (b) rot $\mathbf{F} = \mathbf{0}$

11. (a) Zero (b) rot $\mathbf{F}$ aponta na direção de z negativo

13. $f(x, y, z) = xy^2z^3 + K$ **15.** $f(x, y, z) = x^2y + y^2z + K$

17. Não conservativo **19.** Não

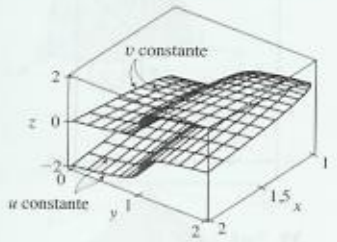
EXERCÍCIOS 16.6 ■ PÁGINA 1023

1. P: não; Q: sim

3. Plano por $(0, 3, 1)$ contendo os vetores $\langle 1, 0, 4\rangle, \langle 1, -1, 5\rangle$

5. Cilindro circular com eixo no eixo x

7.



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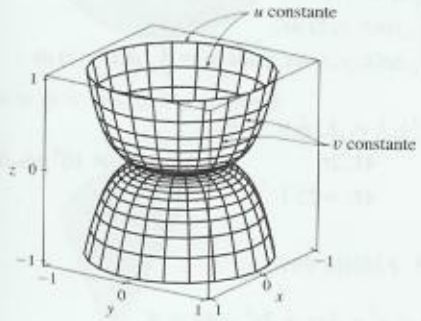

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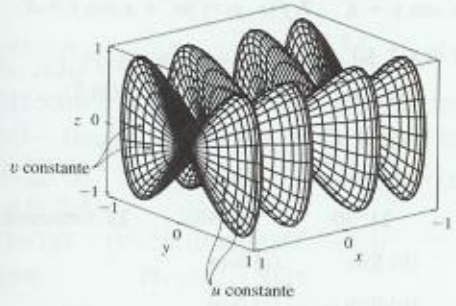


13. IV **15.** II **17.** III

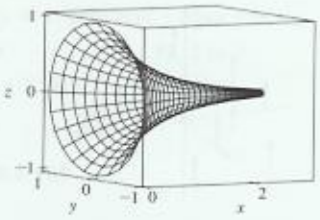
19. $x = 1 + u + v, y = 2 + u - v, z = -3 - u + v$

21. $x = x, z = z, y = \sqrt{1 - x^2 + z^2}$

23. $x = 2 \operatorname{sen}\phi \cos\theta, y = 2 \operatorname{sen}\phi \operatorname{sen}\theta,$
$z = 2\cos\phi, 0 \leq \phi \leq \pi/4, 0 \leq \phi \leq 2\pi$
[ou $x = x, y = y, z = \sqrt{4 - x^2 - y^2}, x^2 + y^2 \leq 2$]

25. $x = x, y = e^{-x}\cos\theta, z = 4 \operatorname{sen}\theta, 0 \leq x \leq 5, 0 \leq \theta \leq 2\pi$

29. $x = x, y = e^{-x}\cos\theta,$
$z = e^{-x}\operatorname{sen}\theta, 0 \leq x \leq 3$
$0 \leq \theta \leq 2\pi$



31. (a) Inverte o sentido (b) O número de voltas dobra

33. $3x - y + 3z = 3$ **35.** $-x + 2z = 1$ **37.** $3\sqrt{14}$

39. $\frac{4}{15}(3^{5/2} - 2^{7/2} + 1)$ **41.** $(2\pi/3)(2\sqrt{2} - 1)$

43. $(\pi/6)(17\sqrt{17} - 5\sqrt{5})$

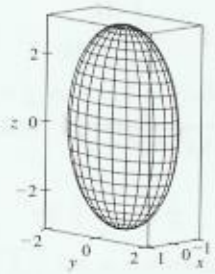
45. $\frac{1}{2}\sqrt{21} + \frac{17}{4}[\ln(2 + \sqrt{21}) - \ln\sqrt{17}]$ **47.** 4

49. 13 9783

51. (a) 24 2055 (b) 24 2476

53. $\frac{45}{8}\sqrt{14} + \frac{15}{16}\ln[(11\sqrt{5} + 3\sqrt{70})/(3\sqrt{5} + \sqrt{70})]$

55. (b)



(c) $\int_0^{2\pi}\int_0^{\pi}\sqrt{36\operatorname{sen}^4u\cos^2v + 9\operatorname{sen}^4u\operatorname{sen}^2v + 4\cos^2u\operatorname{sen}^2u}\,du\,dv$

57. 4π **59.** $2a^2(\pi - 2)$

EXERCÍCIOS 16.7 ■ PÁGINA 1034

1. 49,09 **3.** 900π **5.** $171\sqrt{14}$ **7.** $\sqrt{3}/24$

9. $5\sqrt{5}/48 + 1/240$ **11.** $364\sqrt{2}/3\pi$

13. $(\pi/60)(391\sqrt{17} + 1)$ **15.** 16π **17.** 12

19. $\frac{713}{180}$ **21.** $-\frac{1}{6}$ **23.** 108π **25.** 0 **27.** 48

29. $2\pi + \frac{8}{3}$ **31.** 0,1642 **33.** 3,4895

35. $\iint_S \mathbf{F}\cdot d\mathbf{S} = \iint_D [P(\partial h/\partial x) - Q + R(\partial h/\partial z)]dA$, onde
D = projeção de S no plano xz

37. $(0, 0, a/2)$

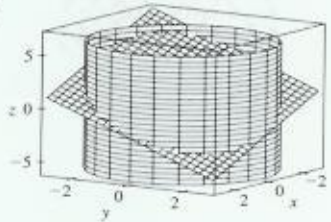
39. (a) $I_z = \iint_S (x^2 + y^2)\rho(x, y, z)\,dS$ (b) $4\,329\sqrt{2}/5$

41. 0 kg/s **43.** $\frac{8}{3}\pi a^3\varepsilon_0$ **45.** $1\,248\pi$

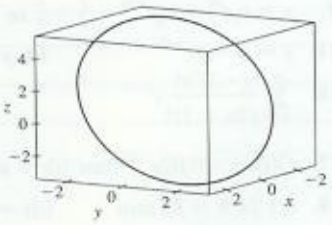
EXERCÍCIOS 16.8 ■ PÁGINA 1039

3. 0 **5.** 0 **7.** 1 **9.** 80π

11. (a) $81\pi/2$ (b)



(c) $x = 3\cos t, y = 3\operatorname{sen} t$, $z = 1 - 3(\cos t + \operatorname{sen} t)$, $0 \leq t \leq 2\pi$



17. 3

EXERCÍCIOS 16.9 ■ PÁGINA 1045

5. 2 **7.** $9\pi/2$ **9.** 0 **11.** $32\pi/3$ **13.** 0

15. $341\sqrt{2}/60 + \frac{81}{20}\operatorname{arcsen}(\sqrt{3}/3)$ **17.** $13\pi/20$

19. Negativo em P_1, positivo em P_2

21. div $\mathbf{F} > 0$ nos quadrantes I, II; div $\mathbf{F} < 0$ nos quadrantes III, IV

CAPÍTULO 16 REVISÃO ■ PÁGINA 1048

Testes Verdadeiro-Falso

1. Falso **3.** Verdadeiro **5.** Falso **7.** Verdadeiro

Exercícios

1. (a) Negativo (b) Positivo **3.** $6\sqrt{10}$ **5.** $\frac{4}{15}$

7. $\frac{110}{3}$ **9.** $\frac{11}{12} - 4/e$ **11.** $f(x, y) = e^y + xe^{xy}$ **13.** 0

17. -8π **25.** $\frac{1}{6}(27 - 5\sqrt{5})$

27. $(\pi/60)(391\sqrt{17} + 1)$ **29.** $-64\pi/3$

33. $-\frac{1}{2}$ **37.** -4 **39.** 21

CAPÍTULO 17

EXERCÍCIOS 17.1 ■ PÁGINA 1058

1. $y = c_1e^{3x} + c_2e^{-2x}$ **3.** $y = c_1\cos(x/2) + c_2\operatorname{sen}(x/2)$

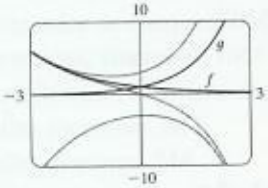
5. $y = c_1e^{2x/3} + c_2xe^{2x/3}$ **7.** $y = c_1 + c_2e^{x/2}$

9. $y = e^{2x}(c_1\cos 3x + c_2\operatorname{sen} 3x)$

11. $y = c_1e^{(\sqrt{3}-1)x/2} + c_2e^{(\sqrt{3}-1)x/2}$

13. $P = e^{-t}\left[c_1\cos\left(\frac{1}{10}t\right) + c_2\operatorname{sen}\left(\frac{1}{10}t\right)\right]$

15.



Todas as soluções tendem ou a 0 ou a $\pm\infty$ quando $x \to \pm\infty$.

17. $y = 2e^{-3x/2} + e^{-x}$ **19.** $y = e^{x/2} - 2xe^{x/2}$

21. $y = 3\cos 4x - \operatorname{sen} 4x$ **23.** $y = e^{-x}(2\cos x + 3\operatorname{sen} x)$

25. $y = 3\cos\left(\frac{1}{2}x\right) - 4\operatorname{sen}\left(\frac{1}{2}x\right)$ **27.** $y = \dfrac{e^{x+3}}{e^3 - 1} + \dfrac{e^{2x}}{1 - e^3}$

29. Nenhuma solução

31. $y = e^{-2x}(2\cos 3x - e^{\pi}\operatorname{sen} 3x)$

33. (b) $\lambda = n^2\pi^2/L^2$, n um inteiro positivo; $y = C\operatorname{sen}(n\pi x/L)$

EXERCÍCIOS 17.2 ■ PÁGINA 1064

1. $y = c_1e^{-2x} + c_2e^{-x} + \frac{1}{2}x^2 - \frac{3}{2}x + \frac{7}{4}$

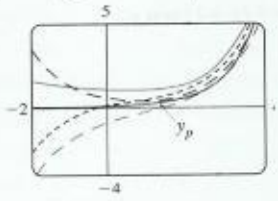
3. $y = c_1 + c_2e^{2x} + \frac{1}{40}\cos 4x - \frac{1}{20}\operatorname{sen} 4x$

5. $y = e^{2x}(c_1\cos x + c_2\operatorname{sen} x) + \frac{1}{10}e^{-x}$

7. $y = \frac{3}{2}\cos x + \frac{11}{2}\operatorname{sen} x + \frac{1}{2}e^x + x^3 - 6x$

9. $y = e^x\left(\frac{1}{2}x^2 - x + 2\right)$

11.



As soluções são todas assintóticas a $y_p = e^x/10$ quando $x \to \infty$. Exceto por y_p, todas as soluções tendem a ∞ ou $-\infty$ quando $x \to -\infty$.

13. $y_p = Ae^{2x} + (Bx^2 + Cx + D)\cos x + (Ex^2 + Fx + G)\operatorname{sen} x$

15. $y_p = Ax + (Bx + C)e^{9x}$

17. $y_p = xe^{-x}[(Ax^2 + Bx + C)\cos 3x + (Dx^2 + Ex + F)\operatorname{sen} 3x]$

19. $y = c_1\cos\left(\frac{1}{2}x\right) + c_2\operatorname{sen}\left(\frac{1}{2}x\right) - \frac{1}{3}\cos x$

21. $y = c_1e^x + c_2xe^x + e^{2x}$

23. $y = c_1\operatorname{sen} x + c_2\cos x + \operatorname{sen} x\ln(\sec x + \operatorname{tg} x) - 1$

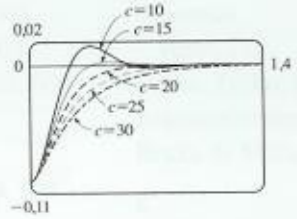
25. $y = [c_1 + \ln(1 + e^{-x})]e^x + [c_2 - e^{-x} + \ln(1 + e^{-x})]e^{2x}$

27. $y = e^x[c_1 + c_2x - \frac{1}{2}\ln(1 + x^2) + x\operatorname{tg}^{-1}x]$

EXERCÍCIOS 17.3 ■ PÁGINA 1071

1. $x = 0{,}35\cos(2\sqrt{5}\,t)$ **3.** $x = -\frac{1}{5}e^{-4t} + \frac{6}{5}e^{-t}$ **5.** $\frac{49}{12}$ kg

7.



13. $Q(t) = (-e^{-10t}/250)(6\cos 20t + 3\operatorname{sen} 20t) + \frac{3}{125}$, $I(t) = \frac{3}{5}e^{-10t}\operatorname{sen} 20t$

15. $Q(t) = e^{-10t}\left[\frac{3}{250}\cos 20t - \frac{3}{500}\operatorname{sen} 20t\right] - \frac{3}{250}\cos 10t + \frac{3}{125}\operatorname{sen} 10t$

EXERCÍCIOS 17.4 ■ PÁGINA 1076

1. $c_0\sum_{n=0}^{\infty}\dfrac{x^n}{n!} = c_0e^x$ **3.** $c_0\sum_{n=0}^{\infty}\dfrac{x^{3n}}{3^n n!} = c_0e^{x^3/3}$

5. $c_0\sum_{n=0}^{\infty}\dfrac{(-1)^n}{2^n n!}x^{2n} + c_1\sum_{n=0}^{\infty}\dfrac{(-2)^n n!}{(2n+1)!}x^{2n+1}$

7. $c_0 + c_1\sum_{n=1}^{\infty}\dfrac{x^n}{n} = c_0 - c_1\ln(1 - x)$ for $|x| < 1$

9. $\sum_{n=0}^{\infty}\dfrac{x^{2n}}{2^n n!} = e^{x^2/2}$

11. $x + \sum_{n=0}^{\infty}\dfrac{(-1)^n 2^2 5^2 \cdot \cdots \cdot (3n-1)^2}{(3n+1)}x^{3n+1}$