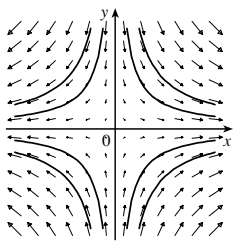
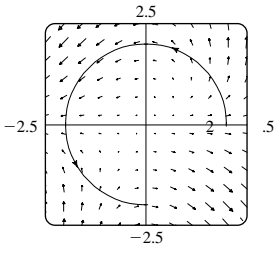
35. (a) 

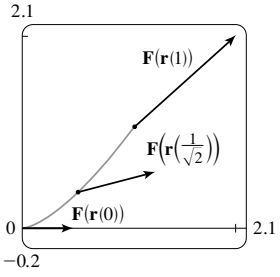
$y = C/x$ (b) $y = 1/x,\ x > 0$

EXERCÍCIOS 16.2

1. $\frac{1}{54}(145^{3/2} - 1)$ **3.** 1638,4 **5.** $\frac{243}{8}$ **7.** $\frac{5}{2}$
9. $\sqrt{5}\,\pi$ **11.** $\frac{1}{12}\sqrt{14}\,(e^6 - 1)$ **13.** $\frac{2}{5}(e - 1)$ **15.** $\frac{35}{3}$
17. (a) Positiva (b) Negativa **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.** $\frac{7}{3}$
43. (a) $2ma\,\mathbf{i} + 6mbt\,\mathbf{j},\ 0 \leq t \leq 1$ (b) $2ma^2 + \frac{9}{2}mb^2$
45. $\approx 1{,}67 \times 10^4$ pés-lb **47.** (b) Sim **51.** ≈ 22 J

EXERCÍCIOS 16.3

1. 40 **3.** $f(x, y) = x^2 - 3xy + 2y^2 - 8y + K$
5. Não conservativo **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) $f(x, y, z) = ye^{xz}$ (b) 4 **19.** 2
21. Não importa qual curva é escolhida.
23. 30 **25.** Não **27.** Conservativo
31. (a) Sim (b) Sim (c) Sim
33. (a) Não (b) Sim (c) Sim

EXERCÍCIOS 16.4

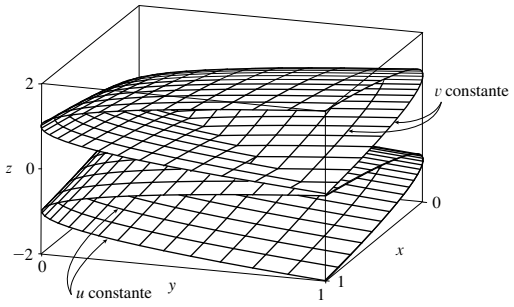
1. 8π **3.** $\frac{2}{3}$ **5.** 12 **7.** $\frac{1}{3}$ **9.** -24π **11.** $-\frac{16}{3}$
13. 4π **15.** $-8e + 48e^{-1}$ **17.** $-\frac{1}{12}$ **19.** 3π **21.** (c) $\frac{9}{2}$
23. $(4a/3\pi, 4a/3\pi)$ se a região é a porção do disco $x^2 + y^2 = a^2$ no primeiro quadrante
27. 0

EXERCÍCIOS 16.5

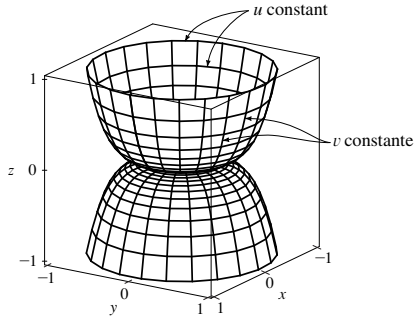
1. (a) $-x^2\,\mathbf{i} + 3xy\,\mathbf{j} - xz\,\mathbf{k}$ (b) yz
3. (a) $ze^x\,\mathbf{i} + (xye^z - yze^x)\,\mathbf{j} - xe^z\,\mathbf{k}$ (b) $y(e^z + e^x)$
5. (a) $\mathbf{0}$ (b) $2/\sqrt{x^2 + y^2 + z^2}$
7. (a) $\langle -e^y \cos z, -e^z \cos x, -e^x \cos y\rangle$
(b) $e^x \operatorname{sen} y + e^y \operatorname{sen} z + e^z \operatorname{sen} x$
9. (a) Negativa (b) rot $\mathbf{F} = \mathbf{0}$
11. (a) Zero (b) rot $\mathbf{F}$ pontos na direção negativa de z
13. $f(x, y, z) = xy^2z^3 + K$ **15.** Não conservativo
17. $f(x, y, z) = xe^{yz} + K$ **19.** Não

EXERCÍCIOS 16.6

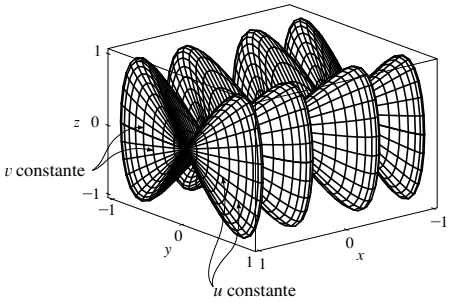
1. P: não; Q: sim
3. Plano por (0, 3, 1) contendo os vetores $\langle 1, 0, 4\rangle, \langle 1, -1, 5\rangle$
5. Paraboloide hiperbólico
7.



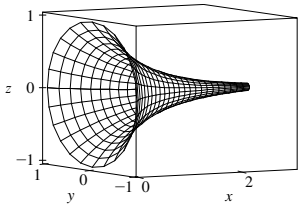
8.



11.



13. IV **15.** II **17.** III
19. $x = u,\ y = v - u,\ z = -v$
21. $y = y,\ z = z,\ x = \sqrt{1 + y^2 + \frac{1}{4}z^2}$
23. $x = 2 \operatorname{sen}\phi \cos\theta,\ y = 2 \operatorname{sen}\phi \operatorname{sen}\theta,$
$z = 2\cos\phi,\ 0 \leq \phi \leq \pi/4,\ 0 \leq \theta \leq 2\pi$
[ou $x = x,\ y = y,\ z = \sqrt{4 - x^2 - y^2},\ x^2 + y^2 \leq 2$]
25. $x = x,\ y = 4\cos\theta,\ z = 4 \operatorname{sen}\theta,\ 0 \leq x \leq 5,\ 0 \leq \theta \leq 2\pi$
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) Direção reversa (b) Número de bobinas duplas

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

37. $-x + 2z = 1$ **39.** $3\sqrt{14}$ **41.** $\sqrt{14}\pi$

43. $\frac{4}{15}(3^{5/2} - 2^{7/2} + 1)$ **45.** $(2\pi/3)(2\sqrt{2} - 1)$

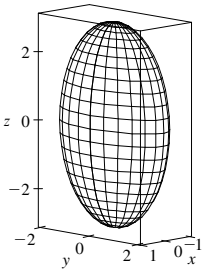
47. $\frac{1}{2}\sqrt{21} + \frac{17}{4}[\ln(2 + \sqrt{21}) - \ln\sqrt{17}]$ **49.** 4

51. $A(S) \leqslant \sqrt{3}\pi R^2$ **53.** 13,9783

55. (a) 24,2055 (b) 24,2476

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

59. (b)



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

61. 4π **63.** $2a^2(\pi - 2)$

EXERCÍCIOS 16.7

1. 49,09 **3.** 900π **5.** $11\sqrt{14}$ **7.** $\frac{2}{3}(2\sqrt{2} - 1)$

9. $171\sqrt{14}$ **11.** $\sqrt{21}/3$ **13.** $364\sqrt{2}\pi/3$

15. $(\pi/60)(391\sqrt{17} + 1)$ **17.** 16π **19.** 12 **21.** 4

23. $\frac{713}{180}$ **25.** $-\frac{4}{3}\pi$ **27.** 0 **29.** 48 **31.** $2\pi + \frac{8}{3}$

33. 4,5822 **35.** 3,4895

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

39. $(0, 0, a/2)$

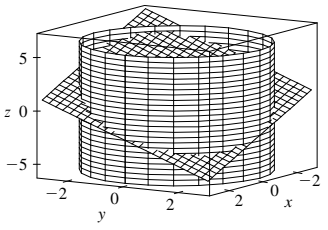
41. (a) $I_z = \iint_S (x^2 + y^2)\rho(x, y, z)\,dS$ (b) $4\,329\sqrt{2}\pi/5$

43. 0 kg/s **45.** $\frac{8}{3}\pi a^3\varepsilon_0$ **47.** $1\,248\pi$

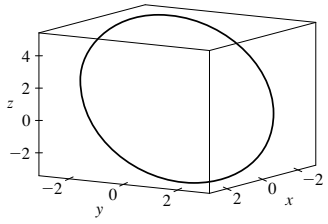
EXERCÍCIOS 16.8

3. 0 **5.** 0 **7.** -1 **9.** 80π

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



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



17. 3

EXERCÍCIOS 16.9

5. $\frac{9}{2}$ **7.** $9\pi/2$ **9.** 0 **11.** $32\pi/3$ **13.** 2π

15. $341\sqrt{2}/60 + \frac{81}{20}\arcsen(\sqrt{3}/3)$

17. $13\pi/20$ **19.** Negativa em P_1, positiva em P_2

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

CAPÍTULO 16 REVISÃO

Teste Verdadeiro-Falso

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

7. Falso **9.** Verdadeiro **11.** Verdadeiro

Exercícios

1. (a) Negativa (b) Positiva **3.** $6\sqrt{10}$ **5.** $\frac{1}{15}$

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

1. $y = c_1e^{3x} + c_2e^{-2x}$ **3.** $y = c_1\cos 4x + c_2\,\text{sen}\,4x$

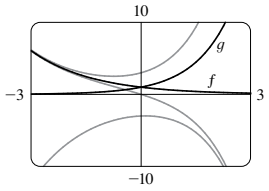
5. $y = c_1e^{2x/3} + c_2\,xe^{2x/3}$ **7.** $y = c_1 + c_2e^{x/2}$

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

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

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

15.



Todas as soluções de tendem a 0 ou $\pm\infty$ à medida que $x \to \pm\infty$.

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

21. $y = e^{3x}(2\cos x - 3\,\text{sen}\,x)$

23. $y = \frac{1}{7}e^{4x-4} - \frac{1}{7}e^{3-3x}$ **25.** $y = 5\cos 2x + 3\,\text{sen}\,2x$

27. $y = 2e^{-2x} - 2xe^{-2x}$ **29.** $y = \frac{e-2}{e-1} + \frac{e^x}{e-1}$

31. Sem solução

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

35. (a) $b - a \neq n\pi$, n qualquer inteiro

(b) $b - a = n\pi$ e $\frac{c}{d} \neq e^{a-b}\frac{\cos a}{\cos b}$ a menos que $\cos b = 0$, então $\frac{c}{d} \neq e^{a-b}\frac{\text{sen}\,a}{\text{sen}\,b}$

(c) $b - a = n\pi$ e $\frac{c}{d} = e^{a-b}\frac{\cos a}{\cos b}$ a menos que $\cos b = 0$, então $\frac{c}{d} = e^{a-b}\frac{\text{sen}\,a}{\text{sen}\,b}$

EXERCÍCIOS 17.2

1. $y = c_1e^{3x} + c_2e^{-x} - \frac{7}{65}\cos 2x - \frac{4}{65}\,\text{sen}\,2x$

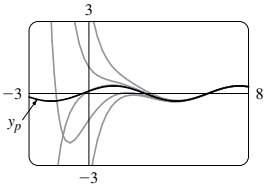
3. $y = c_1\cos 3x + c_2\,\text{sen}\,3x + \frac{1}{13}e^{-2x}$

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

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

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

11.



As soluções são assintóticas a $y_p = \frac{1}{10}\cos x + \frac{3}{10}\,\text{sen}\,x$ quando $x \to \infty$. Exceto por y_p, todas as soluções aproximam-se de ∞ ou $-\infty$ quando $x \to -\infty$.

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

15. $y_p = Axe^x + B\cos x + C\,\text{sen}\,x$

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

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