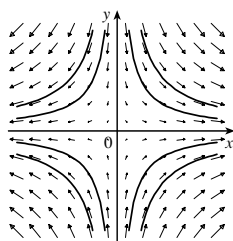


35. (a)

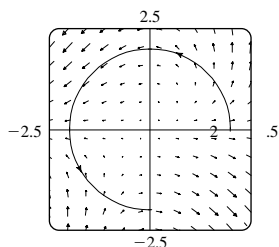


$$y = C/x$$

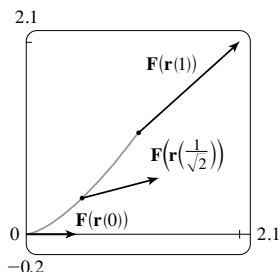
 (b)  $y = 1/x, x > 0$ 

### 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.  $\frac{6}{5} - \cos 1 - \sin 1$     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)  $\bar{x} = (1/m) \int_C xp(x, y, z) ds$ ,  
 $\bar{y} = (1/m) \int_C yp(x, y, z) ds$ ,  
 $\bar{z} = (1/m) \int_C zp(x, y, z) ds$ , onde  $m = \int_C \rho(x, y, z) ds$   
 (b)  $(0, 0, 3\pi)$   
 37.  $I_x = k(\frac{1}{2}\pi - \frac{4}{3})$ ,  $I_y = k(\frac{1}{2}\pi - \frac{2}{3})$     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.  $\approx 22\text{ J}$

### EXERCÍCIOS 16.3

1. 40    3.  $f(x, y) = x^2 - 3xy + 2y^2 - 8y + K$   
 5. Não conservativo    7.  $f(x, y) = ye^x + x \sin y + K$   
 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

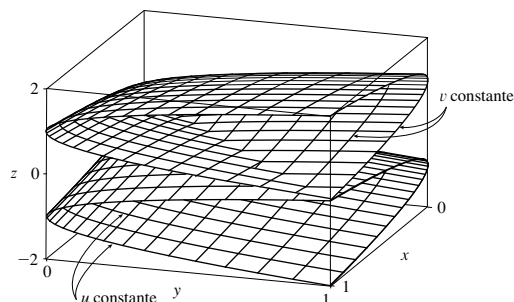
1.  $8\pi$     3.  $\frac{2}{3}$     5. 12    7.  $\frac{1}{3}$     9.  $-24\pi$     11.  $-\frac{16}{3}$   
 13.  $4\pi$     15.  $-8e + 48e^{-1}$     17.  $-\frac{1}{12}$     19.  $3\pi$     21. (c)  $\frac{9}{2}$   
 23.  $(4a/3\pi, 4a/3\pi)$  se a região é a porção do disco  $x^2 + y^2 = a^2$  no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

### EXERCÍCIOS 16.5

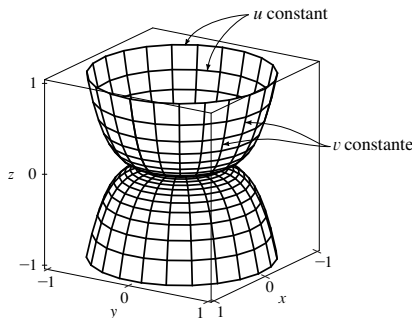
1. (a)  $-x^2\mathbf{i} + 3xy\mathbf{j} - xz\mathbf{k}$     (b)  $yz$   
 3. (a)  $ze^x\mathbf{i} + (xye^x - yze^x)\mathbf{j} - xe^x\mathbf{k}$     (b)  $y(e^z + e^x)$   
 5. (a) 0    (b)  $2/\sqrt{x^2 + y^2 + z^2}$   
 7. (a)  $\langle -e^y \cos z, -e^z \cos x, -e^x \cos y \rangle$   
 (b)  $e^x \sin y + e^y \sin z + e^z \sin x$   
 9. (a) Negativa    (b)  $\text{rot } \mathbf{F} = \mathbf{0}$   
 11. (a) Zero    (b)  $\text{rot } \mathbf{F}$  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

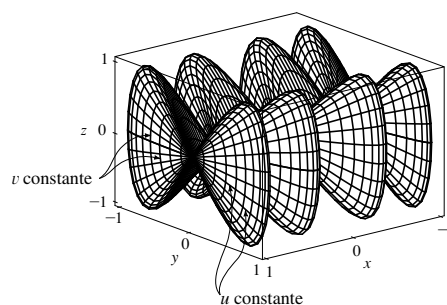
1.  $P$ : não;  $Q$ : sim  
 3. Plano por  $(0, 3, 1)$  contendo os vetores  $\langle 1, 0, 4 \rangle, \langle 1, -1, 5 \rangle$   
 5. Paraboloide hiperbólico  
 7.



8.



11.



13. IV    15. II    17. III

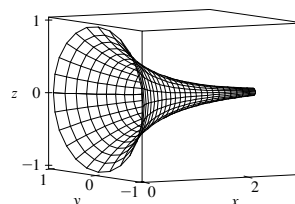
 19.  $x = u, y = v - u, z = -v$ 

 21.  $y = y, z = z, x = \sqrt{1 + y^2 + \frac{1}{4}z^2}$ 

 23.  $x = 2 \sin \phi \cos \theta, y = 2 \sin \phi \sin \theta,$ 
 $z = 2 \cos \phi, 0 \leq \phi \leq \pi/4, 0 \leq \theta \leq 2\pi$ 

 [ou  $x = x, y = y, z = \sqrt{4 - x^2 - y^2}, x^2 + y^2 \leq 2$ ]

 25.  $x = x, y = 4 \cos \theta, z = 4 \sin \theta, 0 \leq x \leq 5, 0 \leq \theta \leq 2\pi$ 

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


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.  $(2\pi/3)(2\sqrt{2} - 1)$

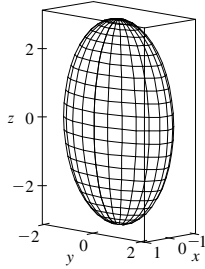
47.  $\frac{1}{2}\sqrt{21} + \frac{17}{4}[\ln(2 + \sqrt{21}) - \ln \sqrt{17}]$  49. 4

51.  $A(S) \leq \sqrt{3}\pi R^2$  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)  $\int_0^{2\pi} \int_0^\pi \sqrt{36 \sin^4 u \cos^2 v + 9 \sin^4 u \sin^2 v + 4 \cos^2 u \sin^2 u} du dv$

61.  $4\pi$  63.  $2a^2(\pi - 2)$

**EXERCÍCIOS 16.7**

1. 49,09 3.  $900\pi$  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.  $16\pi$  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  $xy$ 

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

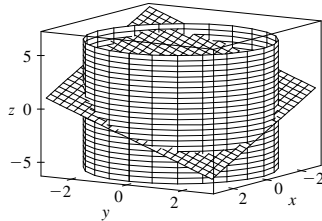
41. (a)  $I_z = \iint_S (x^2 + y^2)\rho(x, y, z) dS$  (b)  $4329\sqrt{2}\pi/5$

43. 0 kg/s 45.  $\frac{8}{3}\pi a^3 \epsilon_0$  47.  $1248\pi$

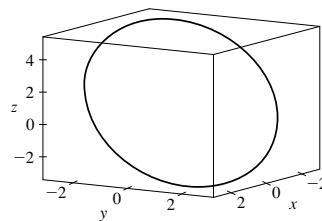
**EXERCÍCIOS 16.8**

3. 0 5. 0 7. -1 9.  $80\pi$

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



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



17. 3

**EXERCÍCIOS 16.9**

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

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

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

21.  $\text{div } \mathbf{F} > 0$  em quadrantes I, II;  $\text{div } \mathbf{F} < 0$  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.  $-8\pi$  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**

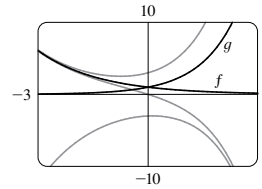
1.  $y = c_1 e^{3x} + c_2 e^{-2x}$  3.  $y = c_1 \cos 4x + c_2 \sin 4x$

5.  $y = c_1 e^{2x/3} + c_2 x e^{2x/3}$  7.  $y = c_1 + c_2 e^{x/2}$

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

11.  $y = c_1 e^{(\sqrt{3}-1)x/2} + c_2 e^{-(\sqrt{3}+1)x/2}$

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

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

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

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

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

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;  $y = C \sin(n\pi x/L)$

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

$$\frac{c}{d} \neq e^{a-b} \frac{\sin a}{\sin b}$$

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

$$\frac{c}{d} = e^{a-b} \frac{\sin a}{\sin b}$$

**EXERCÍCIOS 17.2**

1.  $y = c_1 e^{3x} + c_2 e^{-x} - \frac{7}{65} \cos 2x - \frac{4}{65} \sin 2x$

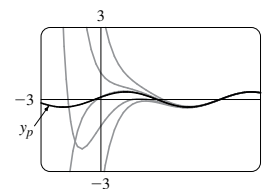
3.  $y = c_1 \cos 3x + c_2 \sin 3x + \frac{1}{13}e^{-2x}$

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

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

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

11.

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

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

15.  $y_p = Axe^x + B \cos x + C \sin x$

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

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