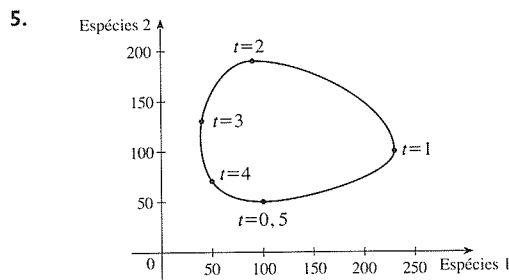
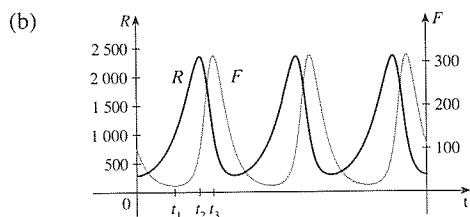


EXERCÍCIOS 9.6 ■ PÁGINA 581

1. (a)  $x$  = predadores,  $y$  = presa; o crescimento é restrito apenas pelos predadores, que se alimentam apenas da presa.  
 (b)  $x$  = presa,  $y$  = predadores; o crescimento é restrito pela capacidade de suporte e pelos predadores, que se alimentam apenas da presa.
3. (a) A população de coelhos começa em cerca de 300, aumenta até 2 400, e então decresce de novo para 300. A população de raposas começa em 100, decresce para cerca de 20, aumenta para cerca de 315, decresce para 100 e o ciclo começa novamente.



9. (a) A população se estabiliza em 5 000.  
 (b) (i)  $W = 0, R = 0$ : populações zero  
 (ii)  $W = 0, R = 5000$ : na ausência de lobos, a população de coelhos é sempre 5 000.  
 (iii)  $W = 64, R = 1 000$ : ambas as populações são estáveis.  
 (c) As populações se estabilizam em 1 000 coelhos e 64 lobos.

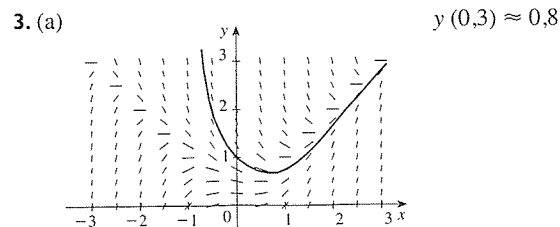
CAPÍTULO 9 REVISÃO ■ PÁGINA 583

Testes Verdadeiro-Falso

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

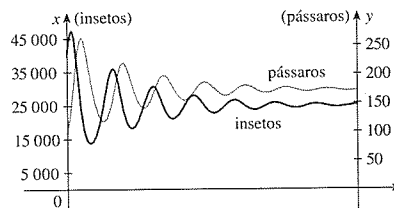
Exercícios

1. (a) (b)  $0 \leq c \leq 4$ ;  
 $y = 0, y = 2, y = 4$



- (b) 0,75676  
 (c)  $y = x$  e  $y = -x$ ; existe um máximo ou um mínimo local

5.  $y = (\frac{1}{2}x^2 + C)e^{-\sin x}$     7.  $y = \pm \sqrt{\ln(x^2 + 2x^{3/2} + C)}$
9.  $r(t) = 5e^{t-t^2}$     11.  $y = \frac{1}{2}x(\ln x)^2 + 2x$     13.  $x = C - \frac{1}{2}y^2$
15. (a)  $P(t) = \frac{2000}{1 + 19e^{-0.1t}}$ ;  $\approx 560$     (b)  $t = 10 \ln \frac{2}{57} \approx 33.5$
17. (a)  $L(t) = L_\infty - [L_\infty - L(0)]e^{-kt}$     (b)  $L(t) = 53 - 43e^{-0.2t}$
19. 15 dias    21.  $k \ln h + h = (-R/V)t + C$
23. (a) Estabiliza em 200 000  
 (b) (i)  $x = 0, y = 0$ : populações zero  
 (ii)  $x = 200 000, y = 0$ : na ausência de pássaros, a população de insetos é sempre 200 000.  
 (iii)  $x = 25 000, y = 175$ : ambas as populações são estáveis.  
 (c) As populações se estabilizam em 25 000 insetos e 175 pássaros.  
 (d)



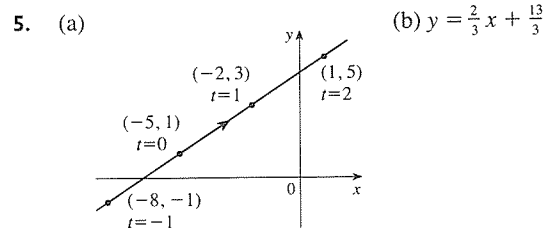
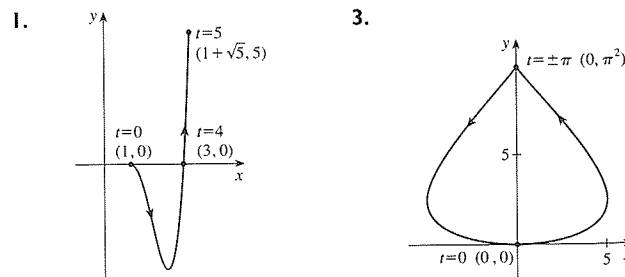
25. (a)  $y = (1/k) \cosh kx + a - 1/k$  ou  
 $y = (1/k) \cosh kx - (1/k) \cosh kb + h$     (b)  $(2/k) \sinh kb$

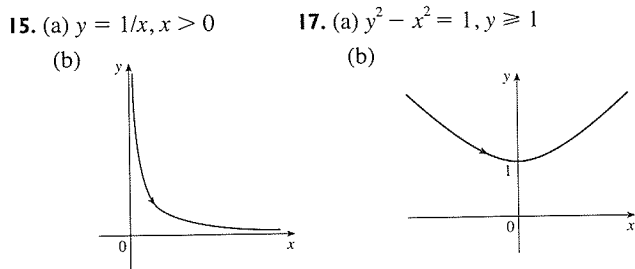
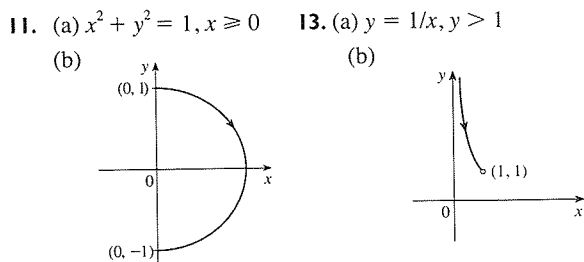
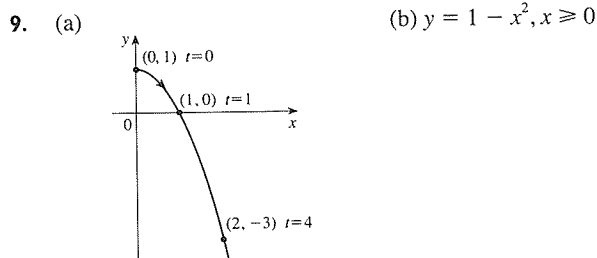
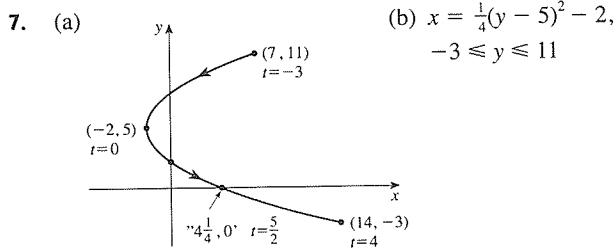
PROBLEMAS QUENTES ■ PÁGINA 586

1.  $f(x) = \pm 10e^x$     5.  $y = x^{1/n}$     7.  $20^\circ\text{C}$
9. (b)  $f(x) = \frac{x^2 - L^2}{4L} - \frac{1}{2}L \ln\left(\frac{x}{L}\right)$     (c) Não
11. (a) 9,5 h    (b)  $2 700\pi \approx 8 482 \text{ m}^2; 471 \text{ m}^2/\text{h}$     (c) 5,5 h
13.  $x^2 + (y - 6)^2 = 25$

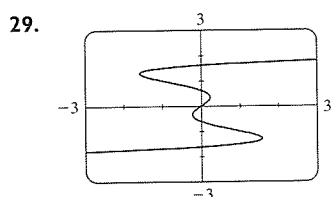
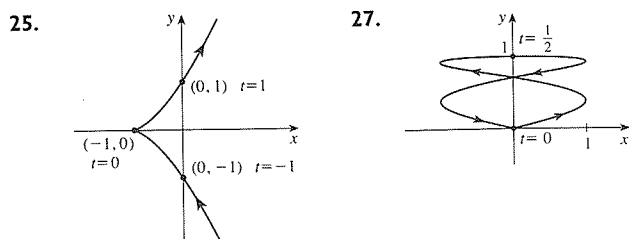
CAPÍTULO 10

EXERCÍCIOS 10.1 ■ PÁGINA 594





19. Se move no sentido anti-horário ao longo do círculo  $x^2 + y^2 = 1$  de  $(-1, 0)$  a  $(1, 0)$
21. Se move três vezes no sentido horário em torno da elipse  $(x^2/25) + (y^2/4) = 1$ , começando e terminando em  $(0, -2)$
23. Está contida no retângulo descrito por  $1 \leq x \leq 4$  e  $2 \leq y \leq 3$ .



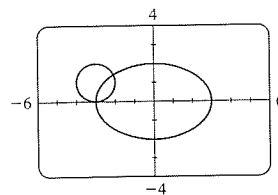
31. (b)  $x = -2 + 5t, y = 7 - 8t, 0 \leq t \leq 1$

33. (a)  $x = 2 \cos t, y = 1 - 2 \sin t, 0 \leq t \leq 2\pi$   
 (b)  $x = 2 \cos t, y = 1 + 2 \sin t, 0 \leq t \leq 6\pi$   
 (c)  $x = 2 \cos t, y = 1 + 2 \sin t, \pi/2 \leq t \leq 3\pi/2$

37. A curva  $y = x^{2/3}$  é gerada em (a). Em (b) é gerada apenas a parte com  $x \geq 0$  e em (c) obtemos apenas a parte com  $x > 0$ .

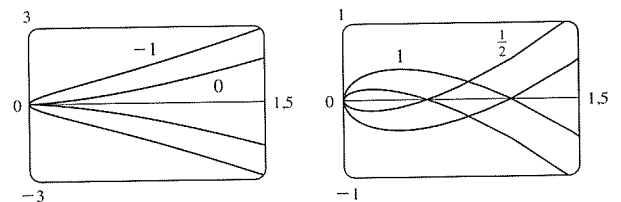
41.  $x = a \cos \theta, y = b \sin \theta; (x^2/a^2) + (y^2/b^2) = 1$ , elipse
- 43.

45. (a) Dois pontos de intersecção



- (b) Um ponto de colisão em  $(-3, 0)$  quando  $t = 3\pi/2$   
 (c) Ainda existem dois pontos de intersecção, mas nenhum ponto de colisão.

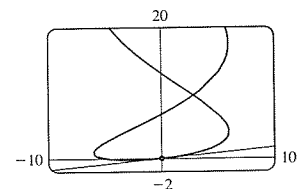
47. Para  $c = 0$ , existe uma cúspide; para  $c > 0$ , existe um laço cujo tamanho aumenta à medida que  $c$  aumenta.



49. Quando  $n$  aumenta, o número de oscilações aumenta;  $a$  e  $b$  determinam a largura e a altura.

EXERCÍCIOS 10.2 ■ PÁGINA 603

1.  $5/(3t^2 - 1)$       3.  $(2 \sin t \cos t)/(\ln t + 1)$   
 5.  $y = -x$       7.  $y = 2x + 1$   
 9.  $y = \frac{1}{6}x$

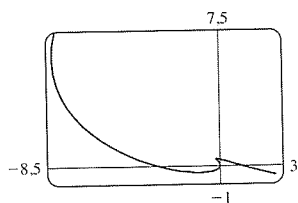


11.  $1 + \frac{3}{2}t, 3/(4t), t > 0$   
 13.  $-e^{-t}, e^{-t}/(1 - e^t), t < 0$   
 15.  $-\frac{3}{2} \operatorname{tg} t, -\frac{3}{4} \sec^3 t, \pi/2 < t < 3\pi/2$   
 17. Horizontal em  $(6, \pm 16)$ , vertical em  $(10, 0)$

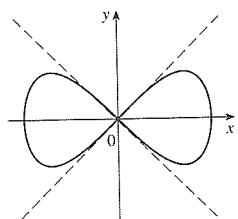
19. Horizontal em  $(\pm\sqrt{2}, \pm 1)$  (quatro pontos), vertical em  $(\pm 2, 0)$

21.  $(0, 6, 2); (5 \cdot 6^{-6/5}, e^{6^{-1/5}})$

23.



25.  $y = x, y = -x$



27. (a)  $d \sin \theta / (r - d \cos \theta)$

29.  $(\frac{16}{27}, \frac{29}{9}), (-2, -4)$

31.  $\pi ab$

33.  $3 - e$

35.  $2\pi r^2 + \pi d^2$

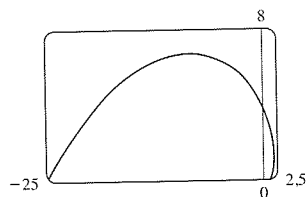
37.  $\int_1^2 \sqrt{1 + 4t^2} dt \approx 3,1678$

39.  $\int_1^{2\pi} \sqrt{3 - 2 \sin t - 2 \cos t} dt \approx 10,0367$

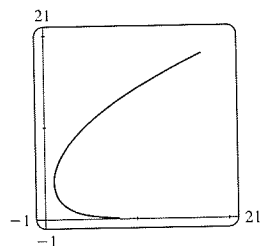
41.  $4\sqrt{2} - 2$

43.  $-\sqrt{10}/3 + \ln(3 + \sqrt{10}) + \sqrt{2} - \ln(1 + \sqrt{2})$

45.  $\sqrt{2}(e^\pi - 1)$



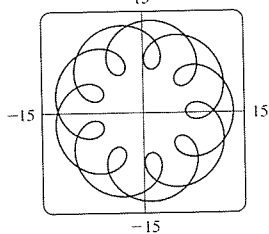
47.  $e^3 + 11 - e^{-8}$



49. 612,3053

51.  $6\sqrt{2}, \sqrt{2}$

55. (a)



$t \in [0, 4\pi]$

(b)  $\approx 294$

57.  $\int_0^1 2\pi(t^2 + 1)e^t \sqrt{e^{2t}(t+1)^2(t^2 + 2t + 2)} dt \approx 103,5999$

59.  $\frac{2}{1215}\pi(247\sqrt{13} + 64)$

61.  $\frac{6}{5}\pi a^2$

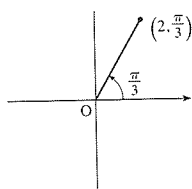
63. 59,101

65.  $\frac{24}{5}\pi(949\sqrt{26} + 1)$

71.  $\frac{1}{4}$

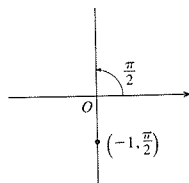
EXERCÍCIOS 10.3 ■ PÁGINA 614

1. (a)



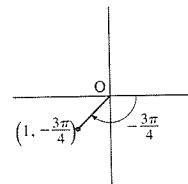
$(2, 7\pi/3), (-2, 4\pi/3)$

(c)



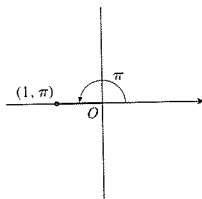
$(1, 3\pi/2), (-1, 5\pi/2)$

(b)



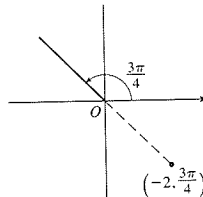
$(1, 5\pi/4), (-1, \pi/4)$

3. (a)



$(-1, 0)$

(c)



$(\sqrt{2}, -\sqrt{2})$

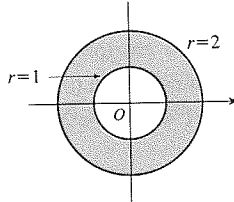
5. (a) (i)  $(2\sqrt{2}, 7\pi/4)$

(ii)  $(-2\sqrt{2}, 3\pi/4)$

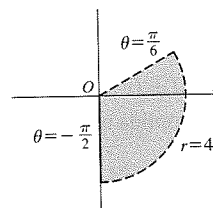
(b) (i)  $(2, 2\pi/3)$

(ii)  $(-2, 5\pi/3)$

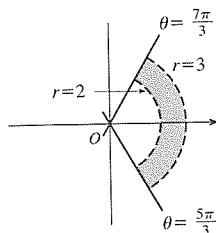
7.



9.



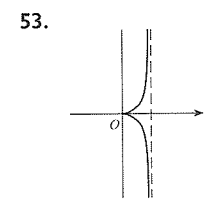
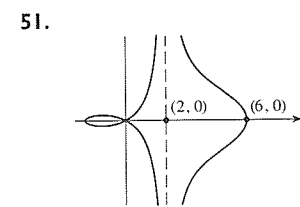
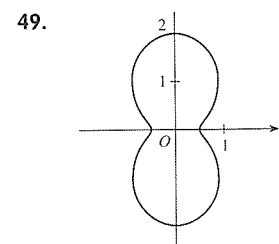
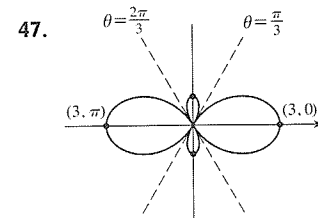
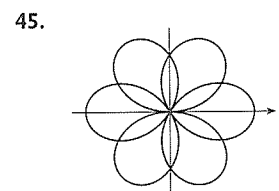
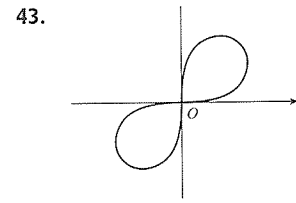
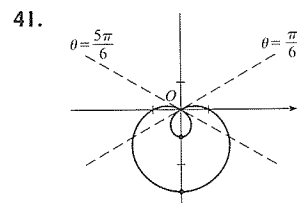
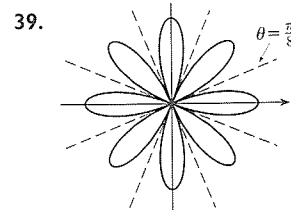
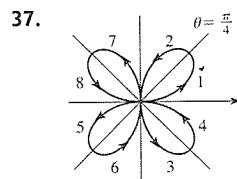
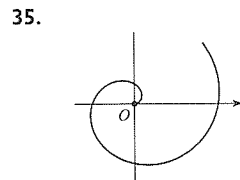
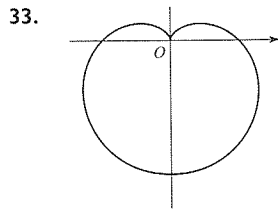
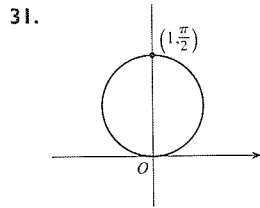
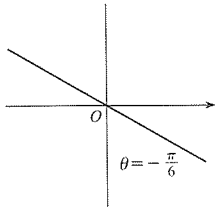
11.



13.  $2\sqrt{3}$

15. Círculo, centro  $O$ , raio 2

17. Círculo, centro  $(0, \frac{3}{2})$ , raio  $\frac{3}{2}$   
 19. Retta horizontal, 1 unidade acima do eixo  $x$   
 21.  $r \operatorname{sen} \theta = 5$     23.  $r = -\operatorname{cotg} \theta \operatorname{cosec} \theta$     25.  $r = 2c \cos \theta$   
 27. (a)  $\theta = \pi/6$     (b)  $x = 3$   
 29.



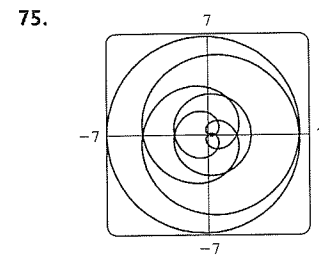
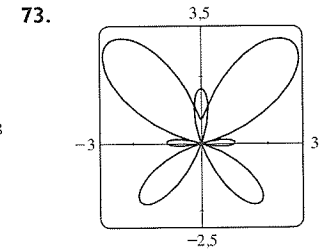
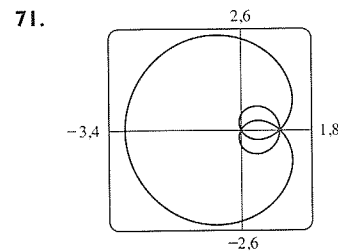
55. (a) Para  $c < -1$ , o laço interno começa em  $\theta = \operatorname{sen}^{-1}(-1/c)$  e termina em  $\theta = \pi - \operatorname{sen}^{-1}(-1/c)$ ; para  $c > 1$ , ele começa em  $\theta = \pi + \operatorname{sen}^{-1}(-1/c)$  e termina em  $\theta = 2\pi - \operatorname{sen}^{-1}(-1/c)$

57.  $\sqrt{3}$

59.  $-\pi$

61. 1

63. Horizontal em  $(3/\sqrt{2}, \pi/4), (-3/\sqrt{2}, 3\pi/4)$ ; vertical em  $(3, 0), (0, \pi/2)$   
 65. Horizontal em  $(\frac{3}{2}, \pi/3), (0, \pi)$  [o polo], e  $(\frac{3}{2}, 5\pi/3)$ ; vertical em  $(2, 0), (\frac{1}{2}, 2\pi/3), (\frac{1}{2}, 4\pi/3)$   
 67. Horizontal em  $(3, \pi/2), (1, 3\pi/2)$ ; vertical em  $(\frac{3}{2} + \frac{1}{2}\sqrt{3}, \alpha), (\frac{3}{2} + \frac{1}{2}\sqrt{3}, \pi - \alpha)$  onde  $\alpha = \operatorname{sen}^{-1}(-\frac{1}{2} + \frac{1}{2}\sqrt{3})$   
 69. Centro  $(b/2, a/2)$ , raio  $\sqrt{a^2 + b^2}/2$



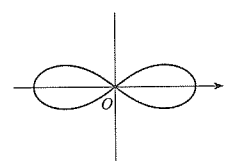
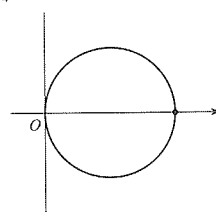
77. Por rotação anti-horária de um ângulo  $\pi/6, \pi/3$ , ou  $\alpha$  em torno da origem.

79. (a) Uma rosácea com  $n$  laços se  $n$  for ímpar e  $2n$  laços se  $n$  for par  
 (b) O número de laços é sempre  $2n$

81. Para  $0 < a < 1$ , a curva é oval e ela desenvolve uma covinha quando  $a \rightarrow 1^-$ . Quando  $a > 1$ , a curva se divide em duas partes, uma das quais tem um laço.

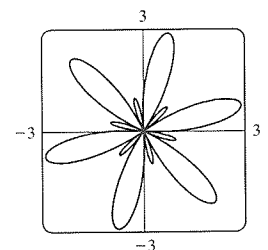
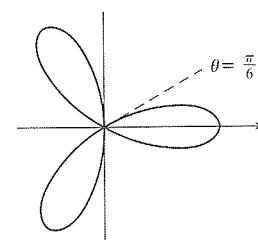
EXERCÍCIOS 10.4 ■ PÁGINA 620

1.  $\pi^5/10 \ 240$     3.  $\pi/12 + \frac{1}{8}\sqrt{3}$     5.  $\pi^3/6$     7.  $\frac{41}{4}$   
 9.  $\frac{9}{4}\pi$     11. 4

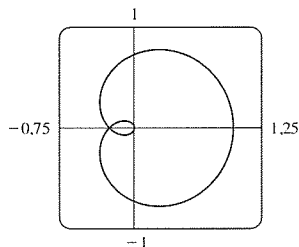


13.  $\pi$

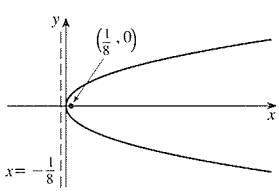
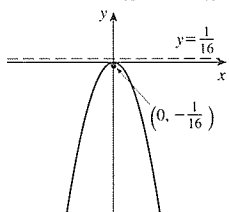
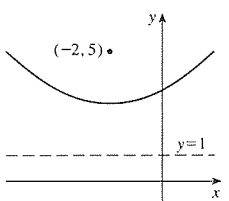
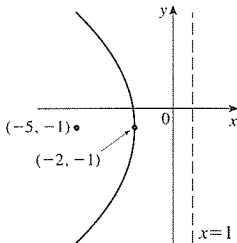
15.  $3\pi$



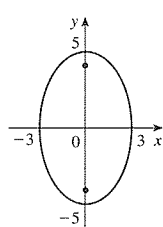
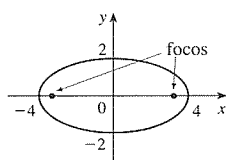
17.  $\frac{1}{8}\pi$     19.  $\frac{9}{20}\pi$     21.  $\pi - \frac{3}{2}\sqrt{3}$     23.  $\frac{1}{3}\pi + \frac{1}{2}\sqrt{3}$   
 25.  $(4\pi/3) + 2\sqrt{3}$     27.  $\pi$     29.  $\frac{5}{24}\pi - \frac{1}{4}\sqrt{3}$   
 31.  $\frac{1}{2}\pi - 1$     33.  $1 - \frac{1}{2}\sqrt{2}$     35.  $\frac{1}{4}(\pi + 3\sqrt{3})$   
 37.  $(\frac{3}{2}, \pi/6), (\frac{3}{2}, 5\pi/6)$ , e o polo  
 39.  $(1, \theta)$  onde  $\theta = \pi/12, 5\pi/12, 13\pi/12, 17\pi/12$  e  $(-1, \theta)$  onde  $\theta = 7\pi/12, 11\pi/12, 19\pi/12, 23\pi/12$   
 41.  $(\frac{1}{2}\sqrt{3}, \pi/3)$ , e o polo  
 43. Intersecção em  $\theta \approx 0,89, 2,25$ ; área  $\approx 3,46$     45.  $\pi$   
 47.  $\frac{8}{3}[(\pi^2 + 1)^{3/2} - 1]$     49. 29,0653    51. 9,6884  
 53.  $\frac{16}{3}$     55. (b)  $2\pi(2 - \sqrt{2})$



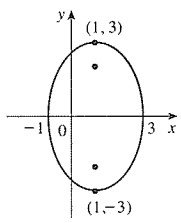
EXERCÍCIOS 10.5 ■ PÁGINA 626

1.  $(0, 0), (\frac{1}{8}, 0), x = -\frac{1}{8}$     3.  $(0, 0), (0, -\frac{1}{16}), y = \frac{1}{16}$   
  
  
 5.  $(-2, 3), (-2, 5), y = 1$     7.  $(-2, -1), (-5, -1), x = 1$   
  


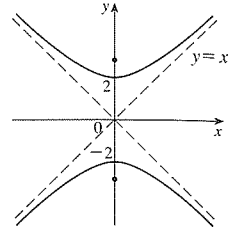
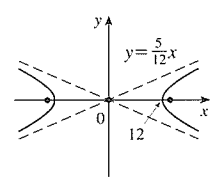
9.  $x = -y^2$ , foco  $(-\frac{1}{4}, 0)$ , diretriz  $x = \frac{1}{4}$   
 11.  $(\pm 4, 0), (\pm 2\sqrt{3}, 0)$     13.  $(0, \pm 5), (0, \pm 4)$



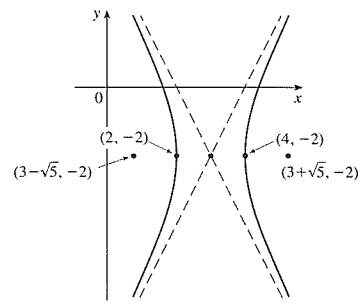
15.  $(1, \pm 3), (1, \pm\sqrt{5})$     17.  $\frac{x^2}{4} + \frac{y^2}{9} = 1$ , focos  $(0, \pm\sqrt{5})$



19.  $(\pm 12, 0), (\pm 13, 0)$ ,  $y = \pm \frac{5}{12}x$     21.  $(0, \pm 2), (0, \pm 2\sqrt{2})$ ,  $y = \pm x$



23.  $(4, -2), (2, -2)$ ;  $(3 \pm \sqrt{5}, -2)$ ;  $y + 2 = \pm 2(x - 3)$



25. Parábola,  $(0, -1), (0, -4^3)$   
 27. Elipse,  $(\pm\sqrt{2}, 1), (\pm 1, 1)$   
 29. Hipérbole,  $(0, 1), (0, -3); (0, -1 \pm \sqrt{5})$     31.  $x^2 = -8y$   
 33.  $y^2 = -12(x + 1)$     35.  $y^2 = 16x$   
 37.  $\frac{x^2}{25} + \frac{y^2}{21} = 1$     39.  $\frac{x^2}{12} + \frac{(y - 4)^2}{16} = 1$   
 41.  $\frac{(x + 1)^2}{12} + \frac{(y - 4)^2}{16} = 1$     43.  $\frac{x^2}{9} - \frac{y^2}{16} = 1$   
 45.  $\frac{(y - 1)^2}{25} - \frac{(x + 3)^2}{39} = 1$     47.  $\frac{x^2}{9} - \frac{y^2}{36} = 1$

49.  $\frac{x^2}{3\,763\,600} + \frac{y^2}{3\,753\,196} = 1$   
 51. (a)  $\frac{x^2}{32\,400} - \frac{y^2}{57\,600} = 1$     (b)  $\approx 320$  km  
 55. (a) Elipse    (b) Hipérbole    (c) Nenhuma curva

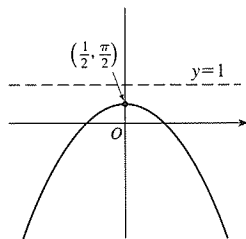
59. 9,69      61.  $\frac{b^2c}{a} + ab \ln\left(\frac{a}{b+c}\right)$  onde  $c^2 = a^2 + b^2$

EXERCÍCIOS 10.6 ■ PÁGINA 634

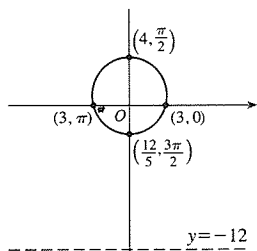
1.  $r = \frac{42}{4 + 7\text{sen } \theta}$       3.  $r = \frac{15}{4 - 3\text{cos } \theta}$

5.  $r = \frac{8}{1 - \text{sen } \theta}$       7.  $r = \frac{4}{2 + \text{cos } \theta}$

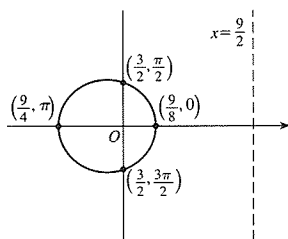
9. (a) 1      (b) Parábola      (c)  $y = 1$   
 (d)      (g)  $\frac{3}{2}$



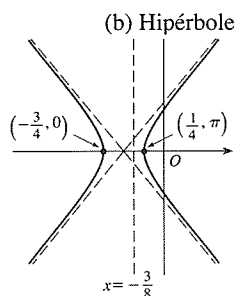
11. (a)  $\frac{1}{4}$       (b) Elipse      (c)  $y = -12$   
 (d)



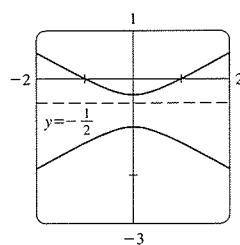
13. (a)  $\frac{1}{3}$       (b) Elipse      (c)  $x = \frac{9}{2}$   
 (d)



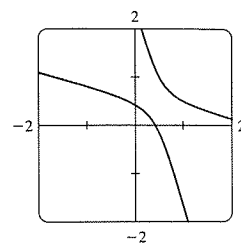
15. (a) 2      (b) Hipérbole      (c)  $x = -\frac{3}{8}$   
 (d)



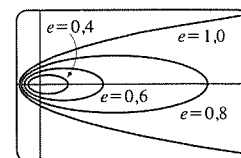
17. (a)  $2, y = -\frac{1}{2}$



(b)  $r = \frac{1}{1 - 2 \text{sen}(\theta - 3\pi/4)}$



19. A elipse é quase circular quando  $e$  está próximo de 0 e se torna mais alongada quando  $e \rightarrow 1^-$ . Em  $e = 1$ , a curva se torna uma parábola.



25.  $r = \frac{2,26 \times 10^8}{1 + 0,093 \text{cos } \theta}$

27. 35,64 AU      29.  $7,0 \times 10^7$  km      31.  $3,6 \times 10^8$  km

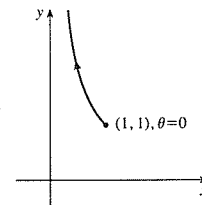
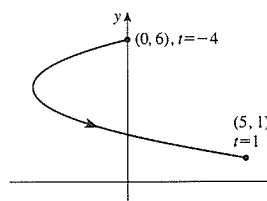
CAPÍTULO 10 REVISÃO ■ PÁGINA 635

Testes Verdadeiro-Falso

1. Falso      3. Falso      5. Verdadeiro      7. Falso      9. Verdadeiro

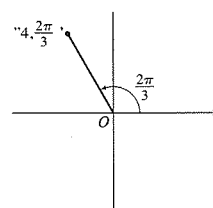
Exercícios

1.  $x = y^2 - 8y + 12$       3.  $y = 1/x$

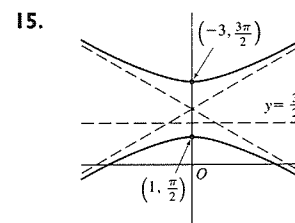
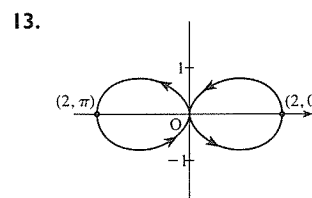
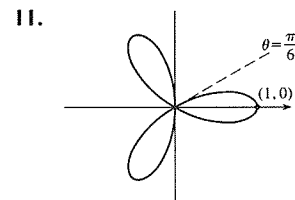
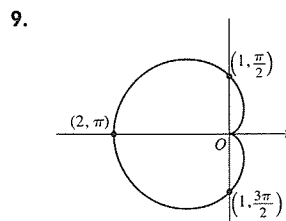


5.  $x = t, y = \sqrt{t}; x = t^4, y = t^2;$   
 $x = \text{tg}^2 t, y = \text{tg } t, 0 \leq t < \pi/2$

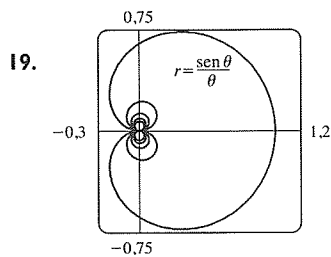
7. (a)      (b)  $(3\sqrt{2}, 3\pi/4),$   
 $(-3\sqrt{2}, 7\pi/4)$



(-2, 2\*sqrt(3))



17.  $r = \frac{2}{\cos \theta + \sin \theta}$



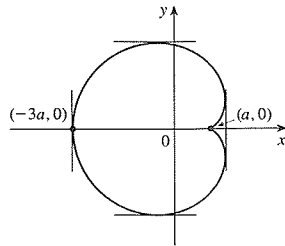
21. 2

23. -1

25.  $\frac{1 + \sin t}{1 + \cos t}, \frac{1 + \cos t + \sin t}{(1 + \cos t)^3}$

27.  $(\frac{11}{8}, \frac{3}{4})$

29. Tangente vertical em  $(\frac{3}{2}a, \pm \frac{1}{2}\sqrt{3}a)$ ,  $(-3a, 0)$ ; tangente horizontal em  $(a, 0)$ ,  $(-\frac{1}{2}a, \frac{3}{2}\sqrt{3}a)$



31. 18

33.  $(2, \pm \pi/3)$

35.  $\frac{1}{2}(\pi - 1)$

37.  $2(5\sqrt{5} - 1)$

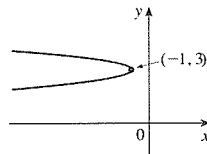
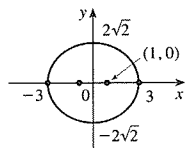
39.  $\frac{2\sqrt{\pi^2 + 1} - \sqrt{4\pi^2 + 1}}{2\pi} + \ln\left(\frac{2\pi + \sqrt{4\pi^2 + 1}}{\pi + \sqrt{\pi^2 + 1}}\right)$

41. 471 295π/1 024

43. Todas as curvas têm a assíntota vertical  $x = 1$ . Para  $c < -1$ , a curva se curva para a direita. Em  $c = -1$ , a curva é a reta  $x = 1$ . Para  $-1 < c < 0$ , ela se curva para a esquerda. Em  $c = 0$  há uma cúspide em  $(0, 0)$ . Para  $c > 0$ , existe um laço.

45.  $(\pm 1, 0), (\pm 3, 0)$

47.  $(-\frac{25}{24}, 3), (-1, 3)$



49.  $\frac{x^2}{25} + \frac{y^2}{9} = 1$

51.  $\frac{y^2}{72/5} - \frac{x^2}{8/5} = 1$

53.  $\frac{x^2}{25} + \frac{(8y - 399)^2}{160\,801} = 1$

55.  $r = \frac{4}{3 + \cos \theta}$

57.  $x = a(\cot \theta + \sin \theta \cos \theta), y = a(1 + \sin^2 \theta)$

PROBLEMAS QUENTES ■ PÁGINA 638

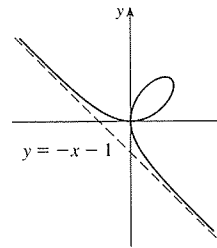
1.  $\ln(\pi/2)$

3.  $[-\frac{3}{4}\sqrt{3}, \frac{3}{4}\sqrt{3}] \times [-1, 2]$

5. (a) Em  $(0, 0)$  e  $(\frac{3}{2}, \frac{3}{2})$

(b) Tangentes horizontais em  $(0, 0)$  e  $(\sqrt[3]{2}, \sqrt[3]{4})$ ; tangentes verticais em  $(0, 0)$  e  $(\sqrt[3]{4}, \sqrt[3]{2})$

(d)



(g)  $\frac{3}{2}$

CAPÍTULO 11

EXERCÍCIOS 11.1 ■ PÁGINA 649

Abreviações: C, convergente; D, divergente

1. (a) Uma sequência é uma lista ordenada de números. Ela também pode ser definida como uma função cujo domínio é o conjunto dos inteiros positivos.

(b) Os termos  $a_n$  tendem a 8 quando  $n$  se torna grande.

(c) Os termos  $a_n$  se tornam grandes quando  $n$  se torna grande.

3. 0,8, 0,96, 0,992, 0,9984, 0,99968    5.  $-3, \frac{3}{2}, -\frac{1}{2}, \frac{1}{8}, -\frac{1}{40}$

7. 3, 5, 9, 17, 33    9.  $a_n = 1/2^n$     11.  $a_n = 5n - 3$

13.  $a_n = (-\frac{2}{3})^{n-1}$     15.  $\frac{1}{3}, \frac{2}{5}, \frac{3}{7}, \frac{4}{9}, \frac{5}{11}, \frac{6}{13}$ , yes;  $\frac{1}{2}$

17. 1    19. 5    21. 1    23. 1    25. 0    27. D

29. 0    31. 0    33. 0    35. 0    37. 1    39.  $e^2$

41.  $\ln 2$     43. D    45. D    47. 1    49.  $\frac{1}{2}$

51. D    53. 0

55. (a) 1 060, 1 123,60, 1 191,02, 126 248, 1 338,23    (b) D

57.  $-1 < r < 1$

59. Convergente pelo Teorema da Sequência Monótona;  $5 \leq L < 8$

61. Decrescente; sim    63. Não monótona; não

65. Decrescente; sim    67. 2    69.  $\frac{1}{2}(3 + \sqrt{5})$

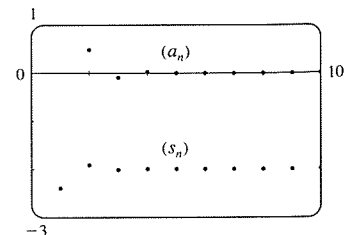
71. (b)  $\frac{1}{2}(1 + \sqrt{5})$     73. (a) 0    (b) 9, 11

EXERCÍCIOS 11.2 ■ PÁGINA 658

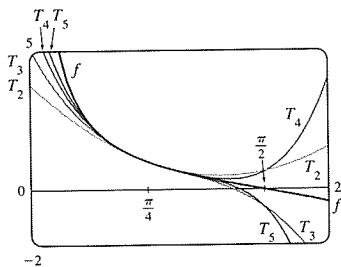
1. (a) Uma sequência é uma lista ordenada de números enquanto uma série é a soma de uma lista de números.

(b) Uma série é convergente se a sequência das somas parciais for uma sequência convergente. A série é divergente se ela não for convergente.

3. -2,40000, -1,92000, -2,01600, -1,99680, -2,00064, -1,99987, -2,00003, -1,99999, -2,00000, -2,00000; convergente, soma = 2



$$11. T_5(x) = 1 - 2\left(x - \frac{\pi}{4}\right) + 2\left(x - \frac{\pi}{4}\right)^2 - \frac{8}{3}\left(x - \frac{\pi}{4}\right)^3 + \frac{10}{3}\left(x - \frac{\pi}{4}\right)^4 - \frac{64}{15}\left(x - \frac{\pi}{4}\right)^5$$



13. (a)  $2 + \frac{1}{4}(x-4) - \frac{1}{64}(x-4)^2$  (b)  $1,5625 \times 10^5$   
 15. (a)  $1 + \frac{2}{3}(x-1) - \frac{1}{9}(x-1)^2 + \frac{4}{81}(x-1)^3$  (b) 0,000097  
 17. (a)  $1 + \frac{1}{2}x^2$  (b) 0,0015    19. (a)  $1 + x^2$  (b) 0,00006  
 21. (a)  $x^2 - \frac{1}{6}x^4$  (b) 0,042    23. 0,17365    25. Quatro  
 27.  $-1,037 < x < 1,037$     29.  $-0,86 < x < 0,86$   
 31. 21 m, não    37. (c) Eles diferem por cerca de  $8 \times 10^{-9}$  km.

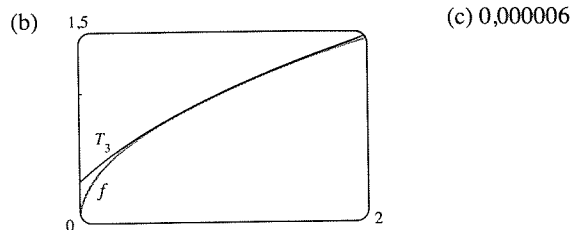
CAPÍTULO 11 REVISÃO ■ PÁGINA 721

Testes Verdadeiro-Falso

1. Falso    3. Verdadeiro    5. Falso    7. Falso  
 9. Falso    11. Verdadeiro    13. Verdadeiro    15. Falso  
 17. Verdadeiro    19. Verdadeiro

Exercícios

1.  $\frac{1}{2}$     3. D    5. 0    7.  $e^{12}$     9. 2    11. C  
 13. C    15. D    17. C    19. C    21. C    23. CC  
 25. AC    27.  $\frac{1}{11}$     29.  $\pi/4$     31.  $e^{-e}$     35. 0,9721  
 37. 0,18976224, erro  $< 6,4 \times 10^{-7}$   
 41. 4, [-6, 2)    43. 0,5, [2,5, 3,5)  
 45.  $\frac{1}{2} \sum_{n=0}^{\infty} (-1)^n \left[ \frac{1}{(2n)!} \left(x - \frac{\pi}{6}\right)^{2n} + \frac{\sqrt{3}}{(2n+1)!} \left(x - \frac{\pi}{6}\right)^{2n+1} \right]$   
 47.  $\sum_{n=0}^{\infty} (-1)^n x^{n+2}, R = 1$     49.  $\sum_{n=1}^{\infty} \frac{x^n}{n}, R = 1$   
 51.  $\sum_{n=0}^{\infty} (-1)^n \frac{x^{8n+4}}{(2n+1)!}, R = \infty$   
 53.  $\frac{1}{2} + \sum_{n=1}^{\infty} \frac{1 \cdot 5 \cdot 9 \cdot \dots \cdot (4n-3)}{n! 2^{6n+1}} x^n, R = 16$   
 55.  $C + \ln|x| + \sum_{n=1}^{\infty} \frac{x^n}{n \cdot n!}$   
 57. (a)  $1 + \frac{1}{2}(x-1) - \frac{1}{8}(x-1)^2 + \frac{1}{16}(x-1)^3$



59.  $-\frac{1}{6}$

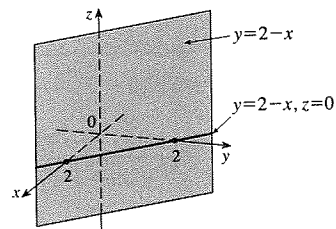
PROBLEMAS QUENTES ■ PÁGINA 725

1.  $15!/5! = 10,897,286,400$   
 3. (b) 0 se  $x = 0$ ,  $(1/x) - \cotg x$  se  $x \neq k\pi$ ,  $k$  inteiro  
 5. (a)  $s_n = 3 \cdot 4^n, I_n = 1/3^n, P_n = 4^n/3^{n-1}$  (c)  $\frac{2}{5}\sqrt{3}$   
 9.  $(-1, 1), \frac{x^3 + 4x^2 + x}{(1-x)^4}$     11.  $\ln \frac{1}{2}$   
 13. (a)  $\frac{250}{101}\pi(e^{-(n-1)\pi/5} - e^{-n\pi/5})$  (b)  $\frac{250}{101}\pi$

CAPÍTULO 12

EXERCÍCIOS 12.1 ■ PÁGINA 732

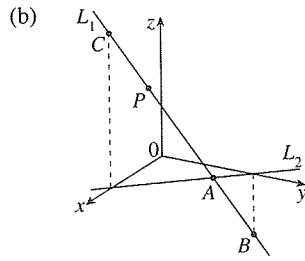
1. (4, 0, -3)    3. Q; R  
 5. Um plano vertical que intercepta o plano xy na reta  $y = 2 - x, z = 0$  (veja o gráfico à direita)



7.  $|PQ| = 6, |QR| = 2s10, |RP| = 6$ ; triângulo isósceles  
 9. (a) Não    (b) Sim  
 11.  $x^2 + (y-1)^2 + (z+1)^2 = 16$ ;  
 $(y-1)^2 + (z+1)^2 = 16, x = 0$   
 13.  $(x-3)^2 + (y-8)^2 + (z-1)^2 = 30$   
 15. (3, -2, 1), 5  
 17.  $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2}), \sqrt{3}/2$     19. (b)  $\frac{5}{2}, \frac{1}{2}\sqrt{94}, \frac{1}{2}\sqrt{85}$   
 21. (a)  $(x-2)^2 + (y+3)^2 + (z-6)^2 = 36$   
 (b)  $(x-2)^2 + (y+3)^2 + (z-6)^2 = 4$   
 (c)  $(x-2)^2 + (y+3)^2 + (z-6)^2 = 9$   
 23. Um plano paralelo ao plano xz e quatro unidades à esquerda dele  
 25. Um semiespaço consistindo em todos os pontos à frente do plano  $x = 3$   
 27. Todos os pontos sobre ou entre os planos horizontais  $z = 0$  e  $z = 6$   
 29. Todos os pontos sobre ou dentro da esfera com raio  $\sqrt{3}$  e centro O  
 31. Todos os pontos sobre ou dentro do cilindro circular de raio 3 e eixo no eixo y  
 33.  $0 < x < 5$     35.  $r^2 < x^2 + y^2 + z^2 < R^2$



37. (a) (2, 1, 4)

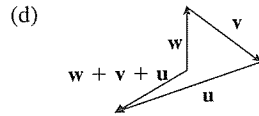
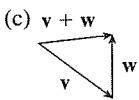
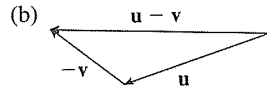
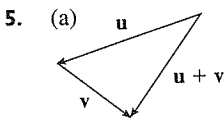


39.  $14x - 6y - 10z = 9$ , um plano perpendicular a  $AB$

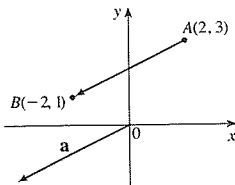
EXERCÍCIOS 12.2 ■ PÁGINA 740

1. (a) Escalar (b) Vetor (c) Vetor (d) Escalar

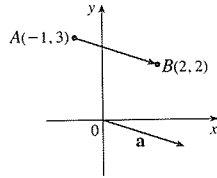
3.  $\vec{AB} = \vec{DC}, \vec{DA} = \vec{CB}, \vec{DE} = \vec{EB}, \vec{EA} = \vec{CE}$



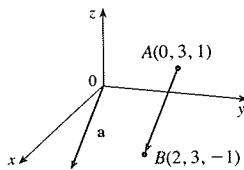
7.  $a = \langle -4, -2 \rangle$



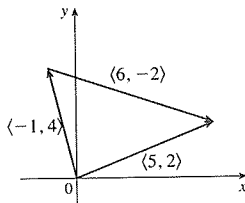
9.  $a = \langle 3, -1 \rangle$



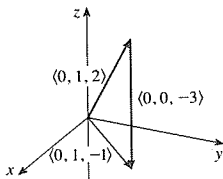
11.  $a = \langle 2, 0, -2 \rangle$



13.  $\langle 5, 2 \rangle$



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



17.  $\langle 2, -18 \rangle, \langle 1, -42 \rangle, 13, 10$

19.  $-i + j + 2k, -4i + j + 9k, \sqrt{14}, \sqrt{82}$

21.  $-\frac{3}{\sqrt{58}}i + \frac{7}{\sqrt{58}}j$       23.  $\frac{8}{9}i - \frac{1}{9}j + \frac{4}{9}k$

25.  $\langle 2, 2\sqrt{3} \rangle$       27.  $\approx 15,32 \text{ m/s}, \approx 12,86 \text{ m/s}$

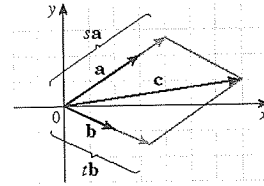
29.  $100\sqrt{7} \approx 264,6 \text{ N}, \approx 139,1^\circ$

31.  $\sqrt{1250} \approx 35,4 \text{ km/h}, \text{N}8^\circ\text{W}$

33.  $T_1 \approx -196i + 3,92j, T_2 \approx 196i + 3,92j$

35.  $\pm(i + 4j)/\sqrt{17}$       37. 0

39. (a), (b)      (d)  $s = \frac{9}{7}, t = \frac{11}{7}$



41. Uma esfera com raio 1, centrada em  $(x_0, y_0, z_0)$

EXERCÍCIOS 12.3 ■ PÁGINA 747

1. (b), (c), (d) têm significado

3. 14      5. -5      7. 32      9. -15

11.  $u \cdot v = \frac{1}{2}, u \cdot w = -\frac{1}{2}$

15.  $\cos^{-1}\left(\frac{9 - 4\sqrt{7}}{20}\right) \approx 95^\circ$       17.  $\cos^{-1}\left(\frac{5}{\sqrt{1015}}\right) \approx 81^\circ$

19.  $\cos^{-1}\left(\frac{-1}{2\sqrt{7}}\right) \approx 101^\circ$

21.  $45^\circ, 45^\circ, 90^\circ$

23. (a) Nenhum dos dois

(b) Ortogonais

(c) Ortogonais

(d) Paralelos

25. Sim

27.  $(i - j - k)/\sqrt{3}$  [ou  $(-i + j + k)/\sqrt{3}$ ]

29.  $\frac{3}{5\sqrt{2}}, \frac{4}{5\sqrt{2}}, \frac{1}{\sqrt{2}}; 65^\circ, 56^\circ, 45^\circ$

31.  $\frac{2}{7}, \frac{3}{7}, \frac{6}{7}; 73^\circ, 65^\circ, 149^\circ$

33.  $1/\sqrt{3}, 1/\sqrt{3}, 1/\sqrt{3}; 55^\circ, 55^\circ, 55^\circ$

35.  $3, \langle \frac{9}{5}, -\frac{12}{5} \rangle$       37.  $\frac{9}{7}, \langle \frac{27}{49}, \frac{54}{49}, -\frac{18}{49} \rangle$

39.  $1/\sqrt{21}, \frac{2}{21}i - \frac{1}{21}j + \frac{4}{21}k$

43.  $\langle 0, 0, -2\sqrt{10} \rangle$  ou qualquer vetor da forma  $\langle s, t, 3s - 2\sqrt{10} \rangle$ ,  $s, t \in \mathbb{R}$

45. 144 J

47.  $560 \cos 20^\circ \approx 526 \text{ J}$

49.  $\frac{13}{5}$

51.  $\cos^{-1}(1/\sqrt{3}) \approx 55^\circ$

EXERCÍCIOS 12.4 ■ PÁGINA 754

1.  $2i - j + 3k$

3.  $15i - 3j + 3k$

5.  $\frac{1}{2}i - j + \frac{3}{2}k$

7.  $t^4i - 2t^3j + t^2k$

9. 0

11.  $i + j + k$

13. (a) Escalar

(b) Sem significado

(c) Vetor

(d) Sem significado

(e) Sem significado

(f) Escalar

15. 24; entrando na página

17.  $\langle 5, -3, 1 \rangle, \langle -5, 3, -1 \rangle$

19.  $\langle -2/\sqrt{6}, -1/\sqrt{6}, 1/\sqrt{6} \rangle, \langle 2/\sqrt{6}, 1/\sqrt{6}, -1/\sqrt{6} \rangle$

27. 16

29. (a)  $\langle 6, 3, 2 \rangle$

(b)  $\frac{7}{2}$

31. (a)  $\langle 13, -14, 5 \rangle$

(b)  $\frac{1}{2}\sqrt{390}$

33. 82

35. 3

39.  $10,8 \text{ sen } 80^\circ \approx 10,6 \text{ N} \cdot \text{m}$

41.  $\approx 417 \text{ N}$

43. (b)  $\sqrt{97/3}$

49. (a) Não (b) Não (c) Sim

EXERCÍCIOS 12.5 ■ PÁGINA 763

1. (a) Verdadeiro (b) Falso (c) Verdadeiro (d) Falso  
 (e) Falso (f) Verdadeiro (g) Falso (h) Verdadeiro  
 (i) Verdadeiro (j) Falso (k) Verdadeiro

3.  $\mathbf{r} = (-2\mathbf{i} + 4\mathbf{j} + 10\mathbf{k}) + t(3\mathbf{i} + \mathbf{j} - 8\mathbf{k})$ ;  
 $x = -2 + 3t, y = 4 + t, z = 10 - 8t$

5.  $\mathbf{r} = (\mathbf{i} + 6\mathbf{k}) + t(\mathbf{i} + 3\mathbf{j} + \mathbf{k})$ ;  $x = 1 + t, y = 3t, z = 6 + t$

7.  $x = 1 - 5t, y = 3, z = 2 - 2t$ ;  $\frac{x-1}{-5} = \frac{z-2}{-2}, y = 3$

9.  $x = 2 + 2t, y = 1 + \frac{1}{2}t, z = 3 - 4t$ ;  
 $(x-2)/2 = 2y-2 = (z+3)/(-4)$

11.  $x = 1 + t, y = -1 + 2t, z = 1 + t$ ;  $x-1 = (y+1)/2 = z-1$

13. Sim

15. (a)  $(x-1)/(-1) = (y+5)/2 = (z-6)/(-3)$

(b)  $(-1, -1, 0), (-\frac{3}{2}, 0, -\frac{3}{2}), (0, -3, 3)$

17.  $\mathbf{r}(t) = (2\mathbf{i} - \mathbf{j} + 4\mathbf{k}) + t(2\mathbf{i} + 7\mathbf{j} - 3\mathbf{k}), 0 \leq t \leq 1$

19. Paralelas

21. Reversas

23.  $-2x + y + 5z = 1$

25.  $x + y - z = -1$

27.  $2x - y + 3z = 0$

29.  $3x - 7z = -9$

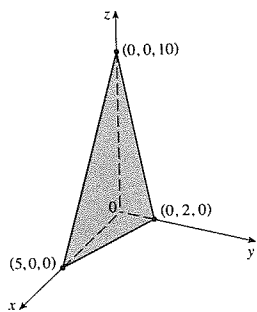
31.  $x + y + z = 2$

33.  $-13x + 17y + 7z = -42$

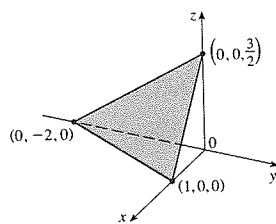
35.  $33x + 10y + 4z = 190$

37.  $x - 2y + 4z = -1$

39.



41.



43.  $(1, 0, 0)$

45.  $(2, 3, 1)$

47.  $1, 0, -1$

49. Perpendiculares 51. Nenhum dos dois,  $\approx 70,5^\circ$

53. Paralelos

55. (a)  $x = 1, y = -t, z = t$  (b)  $\cos^{-1}(\frac{5}{3\sqrt{3}}) \approx 15,8^\circ$

57.  $x = 1, y - 2 = -z$

59.  $x + 2y + z = 5$

61.  $(x/a) + (y/b) + (z/c) = 1$

63.  $x = 3t, y = 1 - t, z = 2 - 2t$

65.  $P_1$  e  $P_3$  são paralelos,  $P_2$  e  $P_4$  são idênticos

67.  $\sqrt{61/14}$

69.  $\frac{18}{7}$

71.  $5/(2\sqrt{14})$

75.  $1/\sqrt{6}$

EXERCÍCIOS 12.6 ■ PÁGINA 771

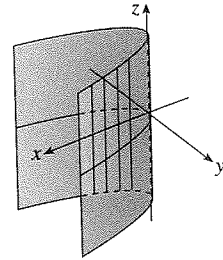
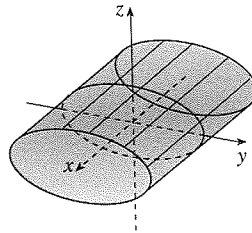
1. (a) Parábola

(b) Cilindro parabólico com geratriz paralela ao eixo  $z$

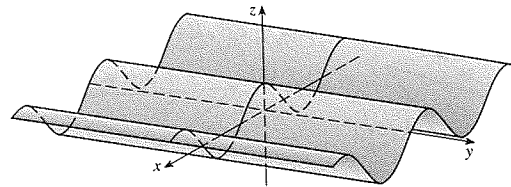
(c) Cilindro parabólico com a geratriz paralela ao eixo  $x$

3. Cilindro elíptico

5. Cilindro parabólico



7. Superfície cilíndrica



9. (a)  $x = k, y^2 - z^2 = 1 - k^2$ , hipérbole ( $k \neq \pm 1$ );

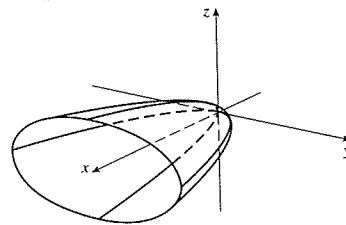
$y = k, x^2 - z^2 = 1 - k^2$ , hipérbole ( $k \neq \pm 1$ );

$z = k, x^2 + z^2 = 1 + k^2$ , círculo

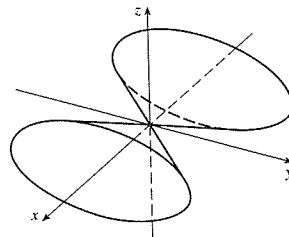
(b) O hiperbolóide é girado de modo que ele tenha eixo no eixo  $y$

(c) O hiperbolóide é transladado uma unidade na direção do eixo  $y$  negativo

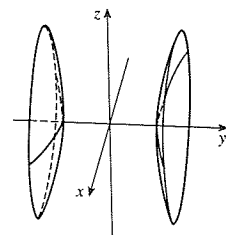
11. Paraboloide elíptico com eixo no eixo  $x$



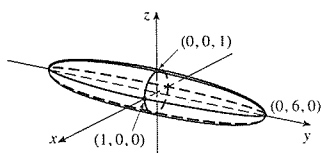
13. Cone elíptico com eixo no eixo  $x$



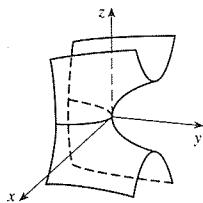
15. Hiperbolóide de duas folhas



17. Elipsoide



19. Paraboloides hiperbolicos



21. VII

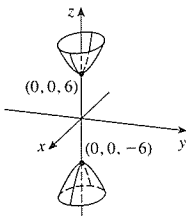
23. II

25. VI

27. VIII

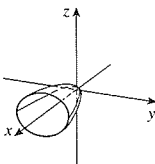
29.  $-\frac{x^2}{9} - \frac{y^2}{4} + \frac{z^2}{36} = 1$

Hiperboloides de duas folhas com eixo no eixo z



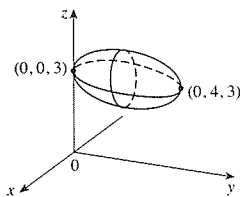
31.  $\frac{x}{6} = \frac{y^2}{3} + \frac{z^2}{2}$

Paraboloides elípticos com vértice (0, 0, 0) e eixo no eixo x



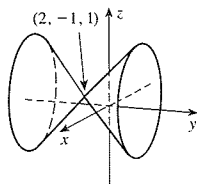
33.  $x^2 + \frac{(y-2)^2}{4} + (z-3)^2 = 1$

Elipsoide com centro (0, 2, 3)

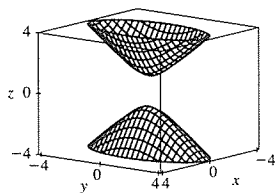


35.  $(y+1)^2 = (x-2)^2 + (z-1)^2$

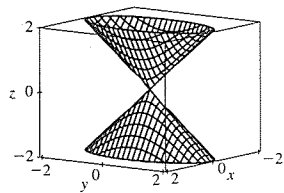
Cone circular com vértice (2, -1, 1) e eixo paralelo ao eixo y



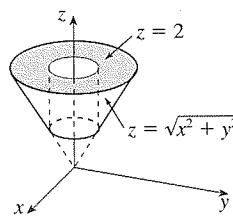
37.



39.



41.



43.  $y = x^2 + z^2$

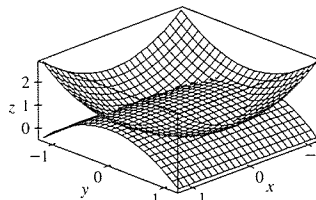
45.  $-4x = y^2 + z^2$ , paraboloides

47. (a)  $\frac{x^2}{(6\,378,137)^2} + \frac{y^2}{(6\,378,137)^2} + \frac{z^2}{(6\,356,523)^2} = 1$

(b) Círculo

(c) Elipse

51.



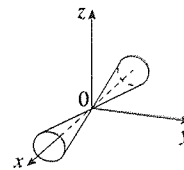
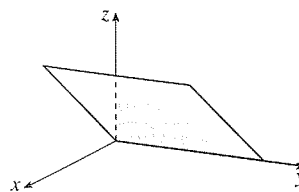
CAPÍTULO 12 REVISÃO ■ PÁGINA 773

Testes Verdadeiro-Falso

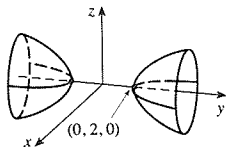
- 1. Verdadeiro    3. Verdadeiro    5. Verdadeiro    7. Verdadeiro
- 9. Verdadeiro    11. Falso    13. Falso    15. Falso
- 17. Verdadeiro

Exercícios

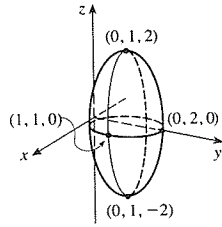
- 1. (a)  $(x+1)^2 + (y-2)^2 + (z-1)^2 = 69$   
 (b)  $(y-2)^2 + (z-1)^2 = 68, x=0$   
 (c) Centro (4, -1, -3), raio 5
- 3.  $\mathbf{u} \cdot \mathbf{v} = 3\sqrt{2}; |\mathbf{u} \times \mathbf{v}| = 3\sqrt{2}$ ; para fora da página
- 5. -2, -4    7. (a) 2    (b) -2    (c) -2    (d) 0
- 9.  $\cos^{-1}(\frac{1}{3}) \approx 71^\circ$     11. (a)  $\langle 4, -3, 4 \rangle$     (b)  $\sqrt{41}/2$
- 13. 166 N, 114 N
- 15.  $x = 4 - 3t, y = -1 + 2t, z = 2 + 3t$
- 17.  $x = -2 + 2t, y = 2 - t, z = 4 + 5t$
- 19.  $-4x + 3y + z = -14$     21. (1, 4, 4)
- 23. Reversas    25.  $x + y + z = 4$
- 27.  $22\sqrt{26}$
- 29. Plano    31. Cone



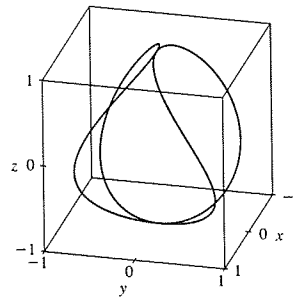
33. Hiperboloide de duas folhas



35. Elipsoide



29.



37.  $4x^2 + y^2 + z^2 = 16$

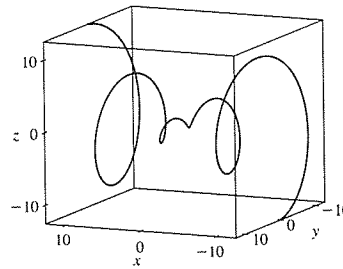
PROBLEMAS QUENTES ■ PÁGINA 776

1.  $(\sqrt{3} - 1, 5)$  m

3. (a)  $(x + 1)/(-2c) = (y - c)/(c^2 - 1) = (z - c)/(c^2 + 1)$

(b)  $x^2 + y^2 = t^2 + 1, z = t$  (c)  $4\pi/3$

31.



CAPÍTULO 13

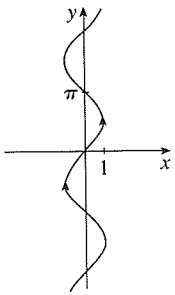
EXERCÍCIOS 13.1 ■ PÁGINA 784

1.  $[1, 5]$

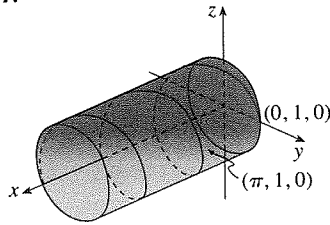
3.  $\langle 1, 0, 0 \rangle$

5.  $\mathbf{i} + \mathbf{j} + \mathbf{k}$

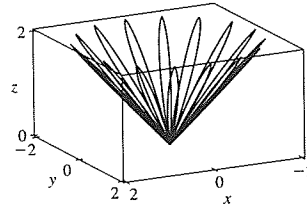
7.



9.



33.

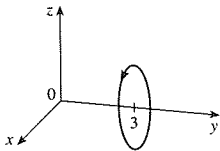


37.  $\mathbf{r}(t) = t\mathbf{i} + \frac{1}{2}(t^2 - 1)\mathbf{j} + \frac{1}{2}(t^2 + 1)\mathbf{k}$

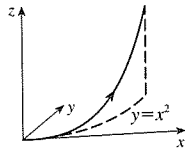
39.  $x = 2 \cos t, y = 2 \sin t, z = 4 \cos^2 t$

41. Sim

11.



13.



15.  $\mathbf{r}(t) = \langle t, 2t, 3t \rangle, 0 \leq t \leq 1; x = t, y = 2t, z = 3t, 0 \leq t \leq 1$

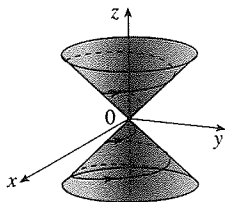
17.  $\mathbf{r}(t) = \langle 3t + 1, 2t - 1, 5t + 2 \rangle, 0 \leq t \leq 1;$   
 $x = 3t + 1, y = 2t - 1, z = 5t + 2, 0 \leq t \leq 1$

19. VI

21. IV

23. V

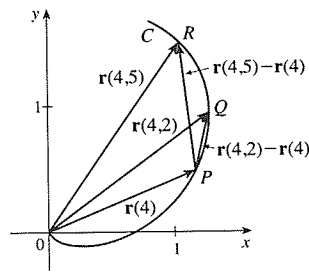
25.



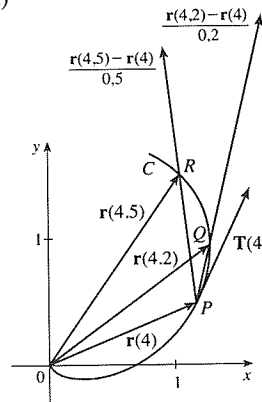
27.  $(0, 0, 0), (1, 0, 1)$

EXERCÍCIOS 13.2 ■ PÁGINA 789

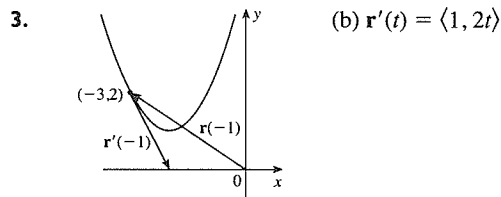
1. (a)



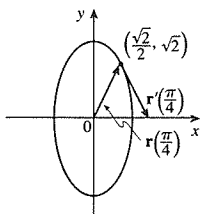
(b), (d)



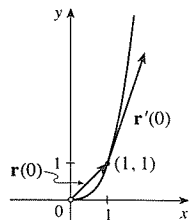
(c)  $\mathbf{r}'(4) = \lim_{h \rightarrow 0} \frac{\mathbf{r}(4+h) - \mathbf{r}(4)}{h}$ ;  $\mathbf{T}(4) = \frac{\mathbf{r}'(4)}{|\mathbf{r}'(4)|}$



5. (a), (c)



7. (a), (c)



(b)  $\mathbf{r}'(t) = \cos t \mathbf{i} - 2 \sin t \mathbf{j}$  (b)  $\mathbf{r}'(t) = e^t \mathbf{i} + 3e^{3t} \mathbf{j}$

9.  $\mathbf{r}'(t) = \langle t \cos t + \sin t, 2t, \cos 2t - 2t \sin 2t \rangle$

11.  $\mathbf{r}'(t) = 4e^{4t} \mathbf{k}$

13.  $\mathbf{r}'(t) = 2te^t \mathbf{i} + [3/(1+3t)] \mathbf{k}$

15.  $\mathbf{r}'(t) = \mathbf{b} + 2t\mathbf{c}$

17.  $\langle 15/\sqrt{262}, 6/\sqrt{262}, 1/\sqrt{262} \rangle$

19.  $\frac{3}{5} \mathbf{j} + \frac{4}{5} \mathbf{k}$

21.  $\langle 1, 2t, 3t^2 \rangle, \langle 1/\sqrt{14}, 2/\sqrt{14}, 3/\sqrt{14} \rangle, \langle 0, 2, 6t \rangle, \langle 6t^2, -6t, 2 \rangle$

23.  $x = 1 + 5t, y = 1 + 4t, z = 1 + 3t$

25.  $x = 1 - t, y = t, z = 1 - t$

27.  $x = t, y = 1 - t, z = 2t$

29.  $x = -\pi - t, y = \pi + t, z = -\pi t$

31.  $66^\circ$

33.  $4\mathbf{i} - 3\mathbf{j} + 5\mathbf{k}$

35.  $\mathbf{i} + \mathbf{j} + \mathbf{k}$

37.  $e^t \mathbf{i} + t^2 \mathbf{j} + (t \ln t - t) \mathbf{k} + \mathbf{C}$

39.  $t^2 \mathbf{i} + t^3 \mathbf{j} + (\frac{2}{3}t^{3/2} - \frac{2}{3}) \mathbf{k}$

45.  $2t \cos t + 2 \sin t - 2 \cos t \sin t$

EXERCÍCIOS 13.3 ■ PÁGINA 797

1.  $20\sqrt{29}$     3.  $e - e^{-1}$     5.  $\frac{1}{27}(13^{3/2} - 8)$     7. 15 3841

9. 1 2780    11. 42

13.  $\mathbf{r}(t(s)) = \frac{2}{\sqrt{29}} s \mathbf{i} + \left(1 - \frac{3}{\sqrt{29}} s\right) \mathbf{j} + \left(5 + \frac{4}{\sqrt{29}} s\right) \mathbf{k}$

15.  $(3 \sin 1, 4, 3 \cos 1)$

17. (a)  $\langle (2/\sqrt{29}) \cos t, 5/\sqrt{29}, (2/\sqrt{29}) \sin t \rangle$ ,  
 $\langle -\sin t, 0, -\cos t \rangle$     (b)  $\frac{2}{29}$

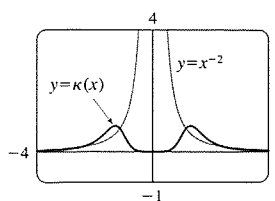
19. (a)  $\langle t^2, 2t, 2 \rangle / (t^2 + 2), \langle 2t, 2 - t^2, -2t \rangle / (t^2 + 2)$     (b)  $2 / (t^2 + 2)$

21.  $2/(4t^2 + 1)^{3/2}$     23.  $\frac{4}{25}$     25.  $\frac{1}{7} \sqrt{\frac{19}{14}}$

27.  $2/(4x^2 - 8 + 5)^{3/2}$     29.  $15\sqrt{x} / (1 + 100x^3)^{3/2}$

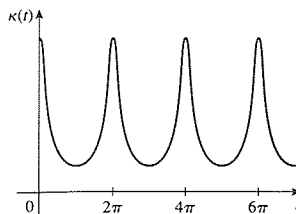
31.  $(-\frac{1}{2} \ln 2, 1/\sqrt{2})$ ; tende a 0    33. (a) P    (b) 1,3, 0,7

35.



37.  $a$  é  $y = f(x)$ ,  $b$  é  $y = \kappa(x)$

39.  $\kappa(t) = \frac{6\sqrt{4 \cos^2 t - 12 \cos t + 13}}{(17 - 12 \cos t)^{3/2}}$



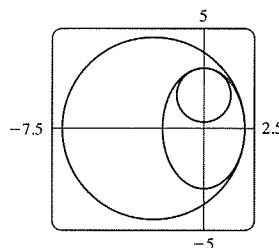
múltiplos inteiros de  $2\pi$

41.  $1/(\sqrt{2}e^t)$

43.  $\langle \frac{2}{3}, \frac{2}{3}, \frac{1}{3} \rangle, \langle -\frac{1}{3}, \frac{2}{3}, -\frac{2}{3} \rangle, \langle -\frac{2}{3}, \frac{1}{3}, \frac{2}{3} \rangle$

45.  $y = 6x + \pi, x + 6y = 6\pi$

47.  $(x + \frac{5}{2})^2 + y = \frac{81}{4}, x^2 + (y - \frac{5}{3})^2 = \frac{16}{9}$



49.  $(-1, -3, 1)$     57.  $2/(t^3 + 4t^2 + 1)$

59.  $2,07 \times 10^{10} \text{ \AA} \approx 2 \text{ m}$

EXERCÍCIOS 13.4 ■ PÁGINA 805

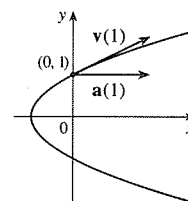
1. (a)  $1,8\mathbf{i} - 3,8\mathbf{j} - 0,7\mathbf{k}, 2,0\mathbf{i} - 2,4\mathbf{j} - 0,6\mathbf{k}$ ,  
 $2,8\mathbf{i} + 1,8\mathbf{j} - 0,3\mathbf{k}, 2,8\mathbf{i} + 0,8\mathbf{j} - 0,4\mathbf{k}$

(b)  $2,4\mathbf{i} - 0,8\mathbf{j} - 0,5\mathbf{k}, 2,58$

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

$\mathbf{a}(t) = \langle 2, 0 \rangle$

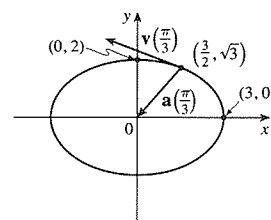
$|\mathbf{v}(t)| = \sqrt{4t^2 + 1}$



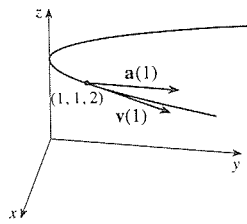
5.  $\mathbf{v}(t) = -3 \sin t \mathbf{i} + 2 \cos t \mathbf{j}$

$\mathbf{a}(t) = -3 \cos t \mathbf{i} - 2 \sin t \mathbf{j}$

$|\mathbf{v}(t)| = \sqrt{5 \sin^2 t + 4}$



7.  $v(t) = i + 2tj$   
 $a(t) = 2j$   
 $|v(t)| = \sqrt{1 + 4t^2}$



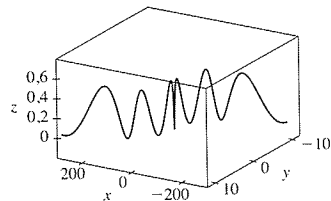
9.  $\langle 1, 2t, 3t^2 \rangle, \langle 0, 2, 6t \rangle, \sqrt{1 + 4t^2 + 9t^4}$

11.  $\sqrt{2}i + e^tj - e^{-t}k, e^tj + e^{-t}k, e^t + e^{-t}$

13.  $e^t[(\cos t - \sin t)i + (\sin t + \cos t)j + (t + 1)k],$   
 $e^t[-2 \sin t i + 2 \cos t j + (t + 2)k], e^t\sqrt{t^2 + 2t + 3}$

15.  $v(t) = ti + 2tj + k, r(t) = (\frac{1}{2}t^2 + 1)i + t^2j + tk$

17. (a)  $r(t) = (\frac{1}{3}t^3 + t)i + (t - \sin t + 1)j + (\frac{1}{4} - \frac{1}{4}\cos 2t)k$   
 (b)



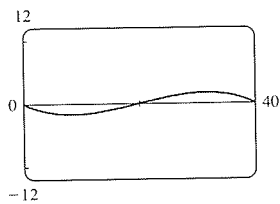
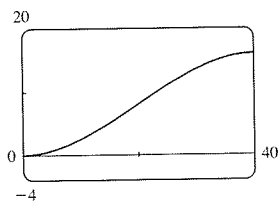
19.  $t = 4$       21.  $r(t) = ti - tj + \frac{5}{2}t^2k, |v(t)| = \sqrt{25t^2 + 2}$

23. (a)  $\approx 22$  km    (b)  $\approx 3,2$  km    (c) 500 m/s

25. 30 m/s      27.  $\approx 10,2, \approx 79,8$

29.  $13,0^\circ < \theta < 36,0^\circ, 55,4^\circ < \theta < 85,5^\circ$

31. (a) 16 m      (b)  $\approx 23,6^\circ$  rio acima



33.  $6t, 6$       35. 0, 1

39.  $4,5 \text{ cm/s}^2, 9,0 \text{ cm/s}^2$

37.  $e^t - e^{-t}, \sqrt{2}$

41.  $t = 1$

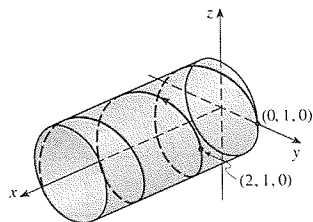
CAPÍTULO 13 REVISÃO ■ PÁGINA 809

Testes Verdadeiro-Falso

1. Verdadeiro      3. Falso      5. Falso  
 7. Verdadeiro      9. Falso      11. Verdadeiro

Exercícios

1. (a)



(b)  $r'(t) = i - \pi \sin \pi t j + \pi \cos \pi t k,$   
 $r''(t) = -\pi^2 \cos \pi t j - \pi^2 \sin \pi t k$

3.  $r(t) = 4 \cos t i + 4 \sin t j + (5 - 4 \cos t)k, 0 \leq t \leq 2\pi$

5.  $\frac{1}{3}i - (2/\pi^2)j + (2/\pi)k$       7. 86,631      9.  $\pi/2$

11. (a)  $\langle t^2, t, 1 \rangle / \sqrt{t^4 + t^2 + 1}$   
 (b)  $\langle 2t, 1 - t^4, -2t^3 - t \rangle / \sqrt{t^8 + 4t^6 + 2t^4 + 5t^2}$   
 (c)  $\sqrt{t^8 + 4t^6 + 2t^4 + 5t^2} / (t^4 + t^2 + 1)^2$

13.  $12/17^{3/2}$       15.  $x - 2y + 2\pi = 0$

17.  $v(t) = (1 + \ln t)i + j - e^{-t}k,$   
 $|v(t)| = \sqrt{2 + 2 \ln t + (\ln t)^2 + e^{-2t}}, a(t) = (1/t)i + e^{-t}k$

19. (a) Cerca de 0,8 m acima do solo, 18,4 m do atleta  
 (b)  $\approx 6,3$  m      (c)  $\approx 19,1$  m do atleta

21. (c)  $-2e^{-t}v_d + e^{-t}R$

PROBLEMAS QUENTES ■ PÁGINA 812

1. (a)  $v = \omega R(-\sin \omega t i + \cos \omega t j)$       (c)  $a = \omega^2 r$

3. (a)  $90^\circ, v_0^2/(2g)$

5. (a)  $\approx 0,25$  m para a direita do lado da mesa,  $\approx 4,9$  m/s  
 (b)  $\approx 5,9^\circ$       (c)  $\approx 0,56$  m para a direita do lado da mesa

7.  $56^\circ$

CAPÍTULO 14

EXERCÍCIOS 14.1 ■ PÁGINA 825

1. (a)  $-27$ ; uma temperatura de  $-15^\circ\text{C}$  com vento soprando a  $40$  km/h dá uma sensação equivalente a cerca de  $-27^\circ\text{C}$  sem vento.

(b) Quando a temperatura é  $-20^\circ\text{C}$ , qual velocidade do vento dá uma sensação térmica de  $-30^\circ\text{C}$ ?  $20$  km/h

(c) Com uma velocidade do vento de  $20$  km/h, qual temperatura dá uma sensação térmica de  $-49^\circ\text{C}$ ?  $-35^\circ\text{C}$

(d) Uma função da velocidade do vento que dá os valores da sensação térmica quando a temperatura é  $-5^\circ\text{C}$

(e) Uma função da temperatura que dá os valores da sensação térmica quando a velocidade do vento é  $50$  km/h

3. Sim

5. (a)  $7,7$ ; um vento de  $80$  km/h soprando em mar aberto por  $15$  h criará ondas de cerca de  $7,7$  m de altura.

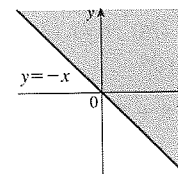
(b)  $f(60, t)$  é uma função de  $t$  que dá a altura das ondas produzidas por ventos de  $60$  km/h soprando por  $t$  horas.

(c)  $f(v, 30)$  é uma função de  $v$  que dá a altura das ondas produzidas por ventos de velocidade  $v$  soprando por  $30$  horas.

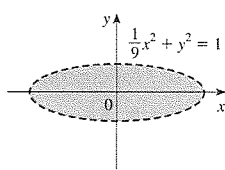
7. (a) 4    (b)  $\mathbb{R}^2$     (c)  $[0, \infty)$

9. (a)  $e$     (b)  $\{(x, y, z) | z \geq x^2 + y^2\}$     (c)  $[1, \infty)$

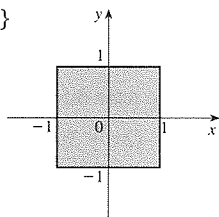
11.  $\{(x, y) | y \geq -x\}$



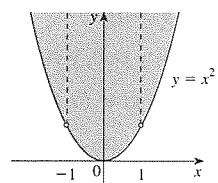
13.  $\{(x, y) | \frac{1}{9}x^2 + y^2 < 1\}$



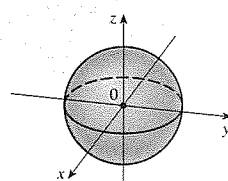
15.  $\{(x, y) | -1 \leq x \leq 1, -1 \leq y \leq 1\}$



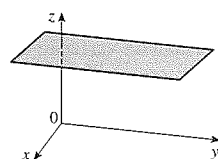
17.  $\{(x, y) | y \geq x^2, x \neq \pm 1\}$



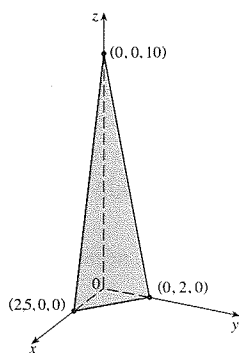
19.  $\{(x, y, z) | x^2 + y^2 + z^2 \leq 1\}$



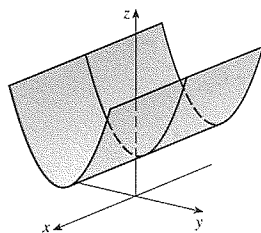
21.  $z = 3$ , plano horizontal



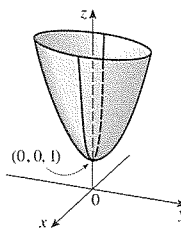
23.  $4x + 5y + z = 10$ , plano



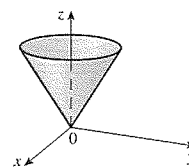
25.  $z = y^2 + 1$ , cilindro parabólico



27.  $z = 4x^2 + y^2 + 1$   
paraboloide elíptico

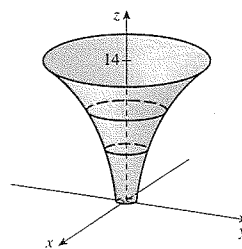


29.  $z = \sqrt{x^2 + y^2}$ ,  
metade de cima do cone



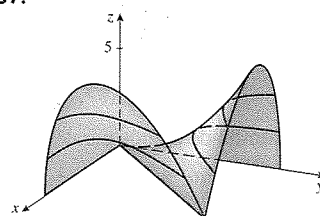
31.  $\approx 56, \approx 35$

35.

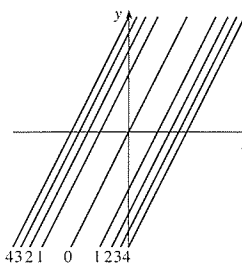


33. Íngreme; quase plano

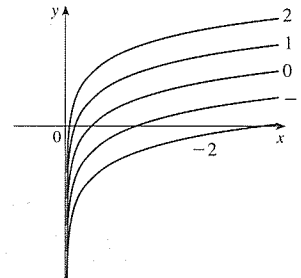
37.



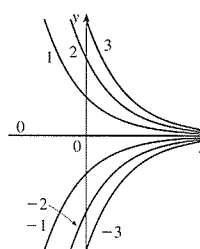
39.  $(y - 2x)^2 = k$



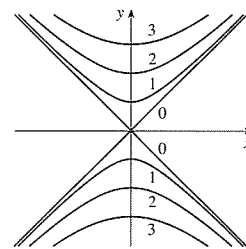
41.  $y = \ln x + k$



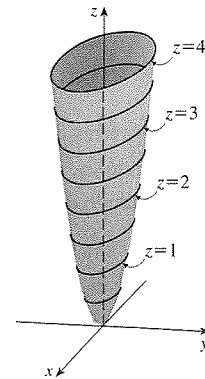
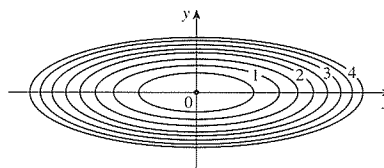
43.  $y = ke^{-x}$



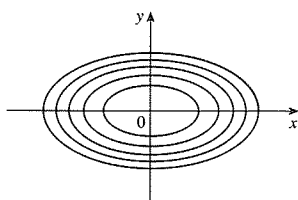
45.  $y^2 - x^2 = k^2$



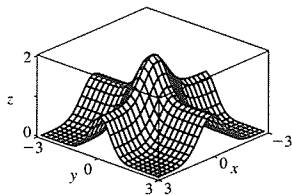
47.  $x^2 + 9y^2 = k$



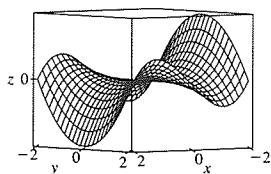
49.



51.



53.



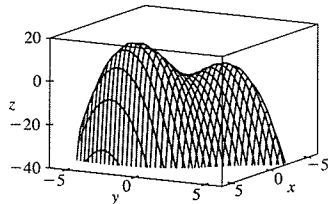
55. (a) C (b) II 57. (a) F (b) I 59. (a) B (b) VI

61. Família de planos paralelos

63. Família de hiperboloides de uma ou duas folhas com eixo no eixo  $y$

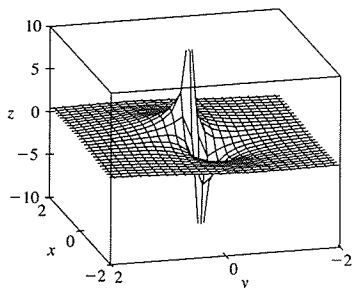
65. (a) Translada o gráfico de  $f$  duas unidades para cima  
 (b) Amplia o gráfico de  $f$  verticalmente por um fator 2  
 (c) Reflete o gráfico de  $f$  em relação ao plano  $xy$   
 (d) Reflete o gráfico de  $f$  em relação ao plano  $xy$  e a seguir translada-o 2 unidades para cima

67.



$f$  parece ter um valor máximo de cerca de 15. Existem dois pontos de máximo locais, mas nenhum ponto de mínimo local.

69.



Os valores da função tendem a 0 quando  $x, y$  se torna grande; quando  $(x, y)$  se aproxima da origem,  $f$  tende a  $\pm\infty$  ou 0, dependendo da direção de aproximação.

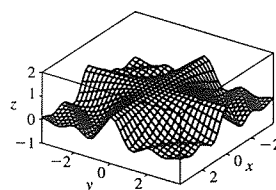
71. Se  $c = 0$ , o gráfico é uma superfície cilíndrica. Para  $c > 0$ , as curvas de nível são elipses. O gráfico se curva para cima à medida que nos afastamos da origem e a inclinação aumenta quando  $c$  aumenta. Para  $c < 0$ , as curvas de nível são hipérbolas. O gráfico se curva para cima na direção  $y$  e para baixo, tendendo ao plano  $xy$ , na direção  $x$  produzindo uma aparência de sela próximo a  $(0, 0, 1)$ .

73.  $c = -2, 0, 2$

75. (b)  $y = 0,75x + 0,01$

EXERCÍCIOS 14.2 ■ PÁGINA 835

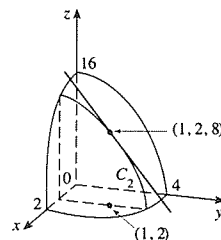
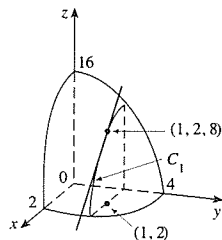
1. Nada; se  $f$  for contínua,  $f(3, 1) = 6$       3.  $-\frac{5}{2}$
5. 2 025      7.  $\frac{2}{7}$       9. Não existe      11. Não existe
13. 0      15. Não existe      17. 2      19. 1
21. Não existe
23. O gráfico mostra que a função tende a números diferentes ao longo de retas diferentes.
25.  $h(x, y) = (2x + 3y - 6)^2 + \sqrt{2x + 3y - 6}$ ;  
 $\{(x, y) | 2x + 3y \geq 6\}$
27. Ao longo da reta  $y = x$       29.  $\{(x, y) | y \neq x^2\}$
31.  $\{(x, y) | y \geq 0\}$       33.  $\{(x, y) | x^2 + y^2 > 4\}$
35.  $\{(x, y, z) | y \geq 0, y \neq \sqrt{x^2 + z^2}\}$
37.  $\{(x, y) | (x, y) \neq (0, 0)\}$       39. 0      41. -1
- 43.



$f$  é contínua em  $\mathbb{R}^2$

EXERCÍCIOS 14.3 ■ PÁGINA 845

1. (a) A taxa de variação da temperatura quando a longitude varia, com a latitude e o tempo fixados; a taxa de variação quando apenas a latitude varia; a taxa de variação quando apenas o tempo varia.  
 (b) Positiva, negativa, positiva
3. (a)  $f_T(-15, 30) \approx 1,3$ ; para uma temperatura de  $-15^\circ\text{C}$  e velocidade do vento de 30 km/h, o índice de sensação térmica aumenta de  $1,3^\circ\text{C}$  para cada grau que a temperatura aumenta.  $f_V(-15, 30) \approx -0,15$ ; para uma temperatura de  $-15^\circ\text{C}$  e velocidade do vento de 30 km/h, o índice de sensação térmica diminui de  $0,15^\circ\text{C}$  para cada km/h de aumento na velocidade do vento.  
 (b) Positiva, negativa      (c) 0
5. (a) Positivo      (b) Negativo
7. (a) Positivo      (b) Negativo
9.  $c = f, b = f_x, a = f_y$
11.  $f_x(1, 2) = -8 =$  inclinação de  $C_1, f_y(1, 2) = -4 =$  inclinação de  $C_2$







9.  $\frac{\partial z}{\partial s} = t^2 \cos \theta \cos \phi - 2st \sin \theta \sin \phi,$   
 $\frac{\partial z}{\partial t} = 2st \cos \theta \cos \phi - s^2 \sin \theta \sin \phi$

11.  $\frac{\partial z}{\partial s} = e^t \left( t \cos \theta - \frac{s}{\sqrt{s^2 + t^2}} \sin \theta \right)$

$\frac{\partial z}{\partial t} = e^t \left( s \cos \theta - \frac{t}{\sqrt{s^2 + t^2}} \sin \theta \right)$

13. 62 15. 7, 2

17.  $\frac{\partial u}{\partial r} = \frac{\partial u}{\partial x} \frac{\partial x}{\partial r} + \frac{\partial u}{\partial y} \frac{\partial y}{\partial r}, \frac{\partial u}{\partial s} = \frac{\partial u}{\partial x} \frac{\partial x}{\partial s} + \frac{\partial u}{\partial y} \frac{\partial y}{\partial s},$

$\frac{\partial u}{\partial t} = \frac{\partial u}{\partial x} \frac{\partial x}{\partial t} + \frac{\partial u}{\partial y} \frac{\partial y}{\partial t},$

19.  $\frac{\partial w}{\partial x} = \frac{\partial w}{\partial r} \frac{\partial r}{\partial x} + \frac{\partial w}{\partial s} \frac{\partial s}{\partial x} + \frac{\partial w}{\partial t} \frac{\partial t}{\partial x},$

$\frac{\partial w}{\partial y} = \frac{\partial w}{\partial r} \frac{\partial r}{\partial y} + \frac{\partial w}{\partial s} \frac{\partial s}{\partial y} + \frac{\partial w}{\partial t} \frac{\partial t}{\partial y}$

21. 85, 178, 54 23.  $\frac{9}{7}, \frac{9}{7}$  25. 36, 24, 30

27.  $\frac{4(xy)^{3/2} - y}{x - 2x^2\sqrt{xy}}$  29.  $\frac{\sin(x-y) + e^y}{\sin(x-y) - xe^y}$

31.  $\frac{3yz - 2x}{2z - 3xy}, \frac{3xz - 2y}{2z - 3xy}$

33.  $\frac{1 + y^2z^2}{1 + y + y^2z^2} - \frac{z}{1 + y + y^2z^2}$

35. 2°C/s 37.  $\approx 0,33$  m/s por minuto

39. (a) 6 m<sup>3</sup>/s (b) 10 m<sup>2</sup>/s (c) 0 m/s

41.  $\approx 0,27$  L/s 43.  $-1/(12\sqrt{3})$  rad/s

45. (a)  $\frac{\partial z}{\partial r} = (\frac{\partial z}{\partial x}) \cos \theta + (\frac{\partial z}{\partial y}) \sin \theta,$   
 $\frac{\partial z}{\partial \theta} = -(\frac{\partial z}{\partial x})r \sin \theta + (\frac{\partial z}{\partial y})r \cos \theta$

51.  $4rs \frac{\partial^2 z}{\partial x^2} + (4r^2 + 4s^2) \frac{\partial^2 z}{\partial x \partial y} + 4rs \frac{\partial^2 z}{\partial y^2} + 2 \frac{\partial z}{\partial y}$

EXERCÍCIOS 14.6 ■ PÁGINA 874

1.  $\approx 0,008$  hPa/km 3.  $\approx 0,778$  5.  $2 + \sqrt{3}/2$

7. (a)  $\nabla f(x, y) = \langle 5y^2 - 12x^2y, 10xy - 4x^3 \rangle$  (b)  $\langle -4, 16 \rangle$   
 (c) 172/13

9. (a)  $\langle e^{2yz}, 2xze^{2yz}, 2xye^{2yz} \rangle$  (b)  $\langle 1, 12, 0 \rangle$  (c)  $-\frac{22}{3}$

11. 23/10 13.  $-8/\sqrt{10}$  15.  $4/\sqrt{30}$  17.  $9/(2\sqrt{5})$

19. 2/5 21.  $4\sqrt{2}, \langle -1, 1 \rangle$  23.  $1, \langle 0, 1 \rangle$

25.  $1, \langle 3, 6, -2 \rangle$  27. (b)  $\langle -12, 92 \rangle$

29. Todos os pontos na reta  $y = x + 1$  31. (a)  $40/(3\sqrt{3})$

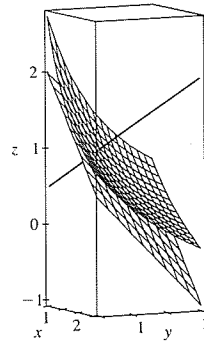
33. (a)  $32/\sqrt{3}$  (b)  $\langle 38, 6, 12 \rangle$  (c)  $2\sqrt{406}$  35.  $\frac{327}{13}$

39. (a)  $x + y + z = 11$  (b)  $x - 3 = y - 3 = z - 5$

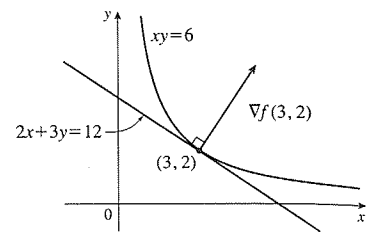
41. (a)  $4x - 5y - z = 4$  (b)  $\frac{x-2}{4} = \frac{y-1}{-5} = \frac{z+1}{-1}$

43. (a)  $x + y - z = 1$  (b)  $x - 1 = y = -z$

45.



47.  $\langle 2, 3 \rangle, 2x + 3y = 12$



53. Não

59.  $x = -1 - 10t, y = 1 - 16t, z = 2 - 12t$

63. Se  $\mathbf{u} = \langle a, b \rangle$  e  $\mathbf{v} = \langle c, d \rangle$ , então  $af_x + bf_y$  e  $cf_x + df_y$  são conhecidos, de modo que podemos resolver as equações lineares para  $f_x$  e  $f_y$ .

EXERCÍCIOS 14.7 ■ PÁGINA 884

1. (a)  $f$  tem um mínimo local em  $(1, 1)$ .  
 (b)  $f$  tem um ponto de sela em  $(1, 1)$ .

3. Mínimo local em  $(1, 1)$ , ponto de sela em  $(0, 0)$

5. Máximo  $f(-1, \frac{1}{2}) = 11$

7. Mínimo  $f(0, 0) = 4$ , pontos de sela em  $(\pm\sqrt{2}, -1)$

9. Ponto de sela em  $(1, 2)$

11. Mínimo  $f(2, 1) = -8$ , ponto de sela em  $(0, 0)$

13. Nenhum 15. Mínimo  $f(0, 0) = 0$ , ponto de sela em  $(\pm 1, 0)$

17. Mínimo  $f(0, 1) = f(\pi, -1) = f(2\pi, 1) = -1$ , ponto de sela em  $(\pi/2, 0), (3\pi/2, 0)$

21. Mínimos  $f(1, \pm 1) = 3, f(-1, \pm 1) = 3$

23. Máximo  $f(\pi/3, \pi/3) = 3\sqrt{3}/2,$

mínimo  $f(5\pi/3, 5\pi/3) = -3\sqrt{3}/2$ , ponto de sela em  $(\pi, \pi)$

25. Mínimos  $f(-1,714, 0) \approx -9,200, f(1,402, 0) \approx 0,242,$   
 ponto de sela  $(0,312, 0)$ , ponto mais baixo  $(-1,714, 0, -9,200)$

27. Máximos  $f(-1,267, 0) \approx 1,310, f(1,629, \pm 1,063) \approx 8,105,$   
 pontos de sela em  $(-0,259, 0), (1,526, 0),$   
 pontos mais altos  $(1,629, \pm 1,063, 8,105)$

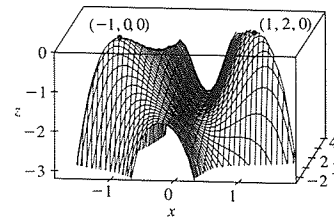
29. Máximo  $f(2, 0) = 9$ , mínimo  $f(0, 3) = -14$

31. Máximo  $f(\pm 1, 1) = 7$ , mínimo  $f(0, 0) = 4$

33. Máximo  $f(3, 0) = 83$ , mínimo  $f(1, 1) = 0$

35. Máximo  $f(1, 0) = 2$ , mínimo  $f(-1, 0) = -2$

37.



39.  $\sqrt{3}$  41.  $(2, 1, \sqrt{5}), (2, 1, -\sqrt{5})$  43.  $\frac{100}{3}, \frac{100}{3}, \frac{100}{3}$

45.  $8r^3/(3\sqrt{3})$  47.  $\frac{4}{3}$  49. Cubo, comprimento da aresta  $c/12$

51. Base quadrada de lado 40 cm, altura 20 cm 53.  $L^3/(3\sqrt{3})$

EXERCÍCIOS 14.8 ■ PÁGINA 893

1.  $\approx 59, 30$
  3. Nenhum máximo, mínimos  $f(1, 1) = f(-1, -1) = 2$
  5. Máximos  $f(\pm 2, 1) = 4$ , mínimos  $f(\pm 2, -1) = -4$
  7. Máximo  $f(1, 3, 5) = 70$ , mínimo  $f(-1, -3, -5) = -70$
  9. Máximo  $2/\sqrt{3}$ , mínimo  $-2/\sqrt{3}$
  11. Máximo  $\sqrt{3}$ , mínimo 1
  13. Máximo  $f(\frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}) = 2$ , mínimo  $f(-\frac{1}{2}, -\frac{1}{2}, -\frac{1}{2}, -\frac{1}{2}) = -2$
  15. Máximo  $f(1, \sqrt{2}, -\sqrt{2}) = 1 + 2\sqrt{2}$ ,  
mínimo  $f(1, -\sqrt{2}, \sqrt{2}) = 1 - 2\sqrt{2}$
  17. Máximo  $\frac{3}{2}$ , mínimo  $\frac{1}{2}$
  19. Máximos  $f(\pm 1/\sqrt{2}, \mp 1/(2\sqrt{2})) = e^{-1/4}$ ,  
mínimos  $f(\pm 1/\sqrt{2}, \pm 1/(2\sqrt{2})) = e^{-1/4}$
- 27-37. Veja os Exercícios 39-49 na Seção 14.7.
39.  $L^3/(3\sqrt{3})$
  41. Mais próximo  $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$ , mais longe  $(-1, -1, 2)$
  43. Máximo  $\approx 9,7938$ , mínimo  $\approx -5,3506$
  45. (a)  $c/n$  (b) Quando  $x_1 = x_2 = \dots = x_n$

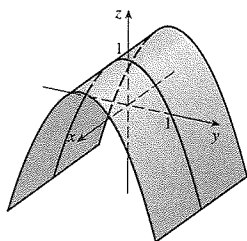
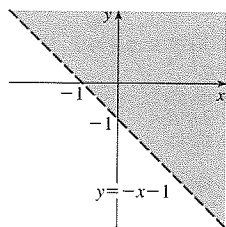
CAPÍTULO 14 REVISÃO ■ PÁGINA 897

Testes Verdadeiro-Falso

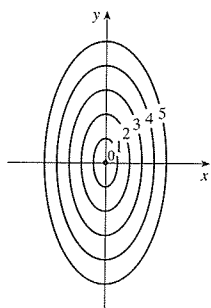
- |               |          |                |
|---------------|----------|----------------|
| 1. Verdadeiro | 3. Falso | 5. Falso       |
| 7. Verdadeiro | 9. Falso | 11. Verdadeiro |

Exercícios

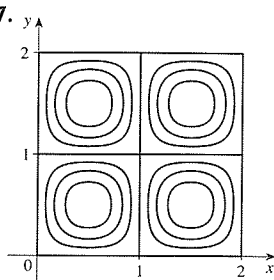
1.  $\{(x, y) | y > -x - 1\}$       3.



5.



7.



9.  $\frac{2}{3}$

11. (a)  $\approx 3,5^\circ\text{C/m}$ ,  $-3,0^\circ\text{C/m}$   
(b)  $\approx 0,35^\circ\text{C/m}$  pela Equação 14.6.9 (a Definição 14.6.2 dá  $\approx 1,1^\circ\text{C/m}$ .) (c)  $-0,25$

13.  $f_x = 1/\sqrt{2x + y^2}$ ,  $f_y = y/\sqrt{2x + y^2}$   
15.  $g_u = \text{tg}^{-1}v$ ,  $g_v = u/(1 + v^2)$

17.  $T_p = \ln(q + e^f)$ ,  $T_q = p/(q + e^f)$ ,  $T_r = pe^f/(q + e^f)$
19.  $f_{xx} = 24x$ ,  $f_{xy} = -2y = f_{yx}$ ,  $f_{yy} = -2x$
21.  $f_{xx} = k(k-1)x^{k-2}y^l z^m$ ,  $f_{xy} = klx^{k-1}y^{l-1}z^m = f_{yx}$ ,  
 $f_{xz} = kmx^{k-1}y^l z^{m-1} = f_{zx}$ ,  $f_{yy} = l(l-1)x^k y^{l-2} z^m$ ,  
 $f_{yz} = lmx^k y^{l-1} z^{m-1} = f_{zy}$ ,  $f_{zz} = m(m-1)x^k y^l z^{m-2}$
25. (a)  $z = 8x + 4y + 1$       (b)  $\frac{x-1}{8} = \frac{y+2}{4} = 1-z$
27. (a)  $2x - 2y - 3z = 3$       (b)  $\frac{x-2}{4} = \frac{y+1}{-4} = \frac{z-1}{-6}$
29. (a)  $4x - y - 2z = 6$   
(b)  $x = 3 + 8t$ ,  $y = 4 - 2t$ ,  $z = 1 - 4t$
31.  $(2, \frac{1}{2}, -1)$ ,  $(-2, -\frac{1}{2}, 1)$
33.  $60x + \frac{24}{5}y + \frac{32}{5}z - 120$ ; 38,656
35.  $2xy^3(1 + 6p) + 3x^2y^2(pe^p + e^p) + 4z^3(p \cos p + \sin p)$
37.  $-47, 108$       43.  $ze^{xy} \langle z\sqrt{y}, xz/(2\sqrt{y}), 2 \rangle$       45.  $\frac{43}{5}$
47.  $\sqrt{145}/2, \langle 4, \frac{9}{2} \rangle$       49.  $\approx \frac{5}{8}$  nós/mi
51. Mínimo  $f(-4, 1) = -11$
53. Máximo  $f(1, 1) = 1$ ; pontos de sela  $(0, 0)$ ,  $(0, 3)$ ,  $(3, 0)$
55. Máximo  $f(1, 2) = 4$ , mínimo  $f(2, 4) = -64$
57. Máximo  $f(-1, 0) = 2$ , mínimo  $f(1, \pm 1) = -3$ , pontos de sela  $(-1, \pm 1)$ ,  $(1, 0)$
59. Máximo  $f(\pm\sqrt{2}/3, 1/\sqrt{3}) = 2/(3\sqrt{3})$ ,  
mínimo  $f(\pm\sqrt{2}/3, -1/\sqrt{3}) = -2/(3\sqrt{3})$
61. Máximo 1, mínimo  $-1$
63.  $(\pm 3^{-1/4}, 3^{-1/4}\sqrt{2}, \pm 3^{1/4})$ ,  $(\pm 3^{-1/4}, 3^{-1/4}\sqrt{2}, \pm 3^{1/4})$
65.  $P(2 - \sqrt{3})$ ,  $P(3 - \sqrt{3})/6$ ,  $P(2\sqrt{3} - 3)/3$

PROBLEMAS QUENTES ■ PÁGINA 902

1.  $L^2W^2, \frac{1}{4}L^2W^2$       3. (a)  $x = w/3$ , base =  $w/3$       (b) Sim
7.  $\sqrt{6}/2, 3\sqrt{2}/2$

CAPÍTULO 15

EXERCÍCIOS 15.1 ■ PÁGINA 912

1. (a) 288      (b) 144
3. (a)  $\pi^2/2 \approx 4,935$       (b) 0
5. (a)  $-6$       (b) 3,5
7.  $U < V < L$
9. (a)  $\approx 248$       (b) 15,5
11. 60      13. 3
15. 1,141606, 1,143191, 1,143535, 1,143617, 1,143637, 1,143642

EXERCÍCIOS 15.2 ■ PÁGINA 917

1.  $500y^3, 3x^2$       3. 10      5. 1      7.  $261,632/45$       9.  $\frac{21}{2} \ln 2$
11. 0      13.  $\pi$       15.  $\frac{21}{2}$       17.  $9 \ln 2$
19.  $\frac{1}{2}(\sqrt{3} - 1) - \frac{1}{12}\pi$       21.  $\frac{1}{2}(e^2 - 3)$