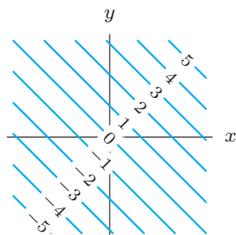


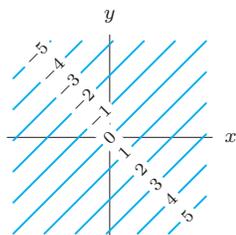
33

		w (gm/m ³)		
		0.1	0.2	0.3
T (°C)	10	1300	900	1200
	20	800	800	900
	30	800	700	800

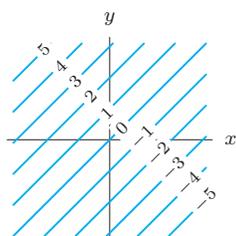
35 (a)



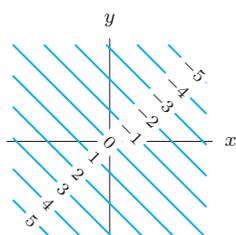
(b)



(c)



(d)



37 $f_y = 0$

39 $f(x, y) = 4x - y$

41 False

43 False

45 True

47 False

49 False

Section 14.2

- 1 (a) 7.01
- (b) 7

3 $f_x(1, 2) = 15$,
 $f_y(1, 2) = -5$

5 $\partial z/\partial x = \frac{14x+7}{(x^2+x-y)^{-6}}$
 $\partial z/\partial y = -7(x^2+x-y)^6$

7 $f_x = 0.6/x$
 $f_y = 0.4/y$

9 $2xy + 10x^4y$

11 $-2\pi r/T^2$

13 $e^{\sqrt{xy}}(1 + \sqrt{xy}/2)$

15 g

17 $(a + b)/2$

19 $2B/u_0$

21 $2mv/r$

23 Gm_1/r^2

25 $-e^{-x^2/a^2}(a^2 - 2x^2)/a^4$

27 $v_0 + at$

29 $-\pi r^{3/2}/(M\sqrt{GM})$

31 $(15x^2y - 3y^2) \cos(5x^3y - 3xy^2)$

33 $\partial F/\partial L = \frac{3}{2}\sqrt{K/L}$

35 $\epsilon_0 E$

37 $c\gamma a_1 b_1 K^{b_1-1}(a_1 K^{b_1} + a_2 L^{b_2})^{\gamma-1}$

39 13.6

41 (a) 3.3, 2.5

(b) 4.1, 2.1

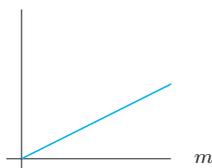
(c) 4, 2

43 (a) $a < 3$

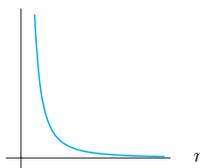
(b) Up

45 (a) $\partial g/\partial m = G/r^2$
 $\partial g/\partial r = -2Gm/r^3$

(b) g



g

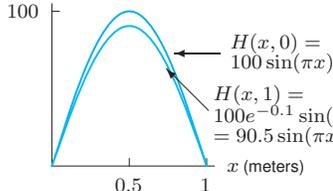


47 (a) $c^2((1 - v^2/c^2)^{-1/2} - 1)$; positive

(b) $mv(1 - v^2/c^2)^{-3/2}$; positive

49 (a)

temp (°C)



(b) $254.2e^{-0.1t}$ °C/m

(c) $-254.2e^{-0.1t}$ °C/m

(d) $-10e^{-0.1t} \sin(\pi x)$ °C/sec

51 $f(x, y) = x^4y^2 - 3xy^4 + C$

53 Derivative is limit, not a difference quotient

Counterexample: $f(x, y) = x^2 + y^2$

55 $f(x, y) = xy, g(x, y) = xy + y^2$

57 True

59 True

61 False

63 False

65 (d)

Section 14.3

1 $z = ex$

3 $z = 6y - 9$

5 $z = -4 + 2x + 4y$

7 $z = -36x - 24y + 148$

9 $df = y \cos(xy) dx + x \cos(xy) dy$

11 $dz = -e^{-x} \cos(y) dx - e^{-x} \sin(y) dy$

13 $dg = 4 dx$

15 $dP \approx 2.395 dK + 0.008 dL$

17 (a) Dollars/Square foot

(b) Larger plots at same distance \$3/ft² more

(c) Dollars/Foot

(d) Farther from beach but same area \$2/ft less

(e) 998 ft²

19 (b) $f(x, y) \approx$

$0.3345 - 0.33(x - 1) - 0.15(y - 2)$

(c) $f(x, y) \approx 0.3345 -$

$0.3345(x - 1) - 0.1531(y - 2)$

21 376

23 $df = \frac{1}{3} dx + 2 dy$

$f(1.04, 1.98) \approx 2.973$

25 136.09°C

27 $P(r, L) \approx$

$80 + 2.5(r - 8) + 0.02(L - 4000)$

$P(r, L) \approx$

$120 + 3.33(r - 8) + 0.02(L - 6000)$

$P(r, L) \approx$

$160 + 3.33(r - 13) + 0.02(L - 7000)$

31 (a) $nRT/(V - nb) - n^2a/V^2$

(b) $\Delta P \approx \frac{(nR/(V_0 - nb))\Delta T + (2n^2a/V_0^3 - nRT_0/((V_0 - nb)^2))\Delta V}{(V_0 - nb)^2}$

33 (a) $d\rho = -\beta\rho dT$

(b) 0.00015, $\beta \approx 0.0005$

35 $-43200\Delta t$

Slow if $\Delta t > 0$; fast if $\Delta t < 0$

37 $z = f(3, 4) + f_x(3, 4)(x - 3) +$

$f_y(3, 4)(y - 4)$

39 Equation not linear

41 sphere of radius 3 centered at the origin

43 True

45 False

47 True

49 False

Section 14.4

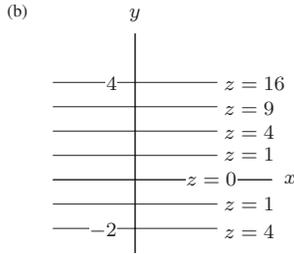
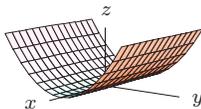
1 $(\frac{15}{2}x^4)\vec{i} - (\frac{24}{7}y^5)\vec{j}$

3 $2m\vec{i} + 2n\vec{j}$

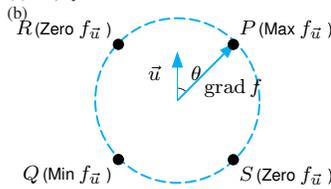
5 $(\frac{5\alpha}{\sqrt{5\alpha^2 + \beta}})\vec{i} + (\frac{1}{2\sqrt{5\alpha^2 + \beta}})\vec{j}$

7 $\nabla z = e^y\vec{i} + e^y(1 + x + y)\vec{j}$

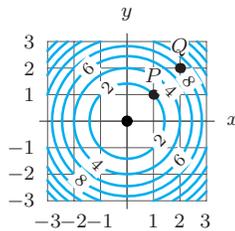
- 9 $\sin \theta \vec{i} + r \cos \theta \vec{j}$
 11 $\nabla z = \frac{1}{y} \cos\left(\frac{x}{y}\right) \vec{i} - \frac{x}{y^2} \cos\left(\frac{x}{y}\right) \vec{j}$
 13 $\left(\frac{-12\beta}{(2\alpha - 3\beta)^2}\right) \vec{i} + \left(\frac{12\alpha}{(2\alpha - 3\beta)^2}\right) \vec{j}$
 15 $60\vec{i} + 85\vec{j}$
 17 $10\pi\vec{i} + 4\pi\vec{j}$
 19 $(\pi/2)^{1/2} \vec{i}$
 21 $\frac{1}{100}(2\vec{i} - 6\vec{j})$
 23 $-46/5$
 25 $22/5$
 27 $84/5$
 29 $(2x + 3e^y)dx + 3xe^y dy$
 31 $(x + 1)ye^{xy} \vec{i} + xe^{xy} \vec{j}$
 33 Negative
 35 Positive
 37 Positive
 39 $-\vec{j}$
 41 \vec{j}
 43 $-\vec{i} - \vec{j}$
 45 $\vec{i} - \vec{j}$
 47 (a) (3.96838, 5.09487)
 (b) 0.1052
 (c) $1/(3\sqrt{10})$
 49 4.4
 51 (a) $-16\vec{i} + 12\vec{j}$
 (b) $16\vec{i} - 12\vec{j}$
 (c) $12\vec{i} + 16\vec{j}$; answers may vary
 53 (a) -3.268
 (b) -4.919
 55 (a) Should be number
 (b) $11/5$
 57 -0.5; better estimate is -1.35
 59 -1.1; better estimate is -1.8
 61 $4\vec{i} + 6\vec{j}$; $4(x - 2) + 6(y - 3) = 0$
 63 $-4\vec{i} + \vec{j}$; $-4(x - 2) + (y - 3) = 0$
 65 (a) Negative
 (b) Negative
 67 (a) Negative
 (b) Positive
 (c) Positive
 (d) Negative
 69 Yes
 71 Yes
 73 (a)



- (c) \vec{j}
 75 (a) Circles centered at P
 (b) away from P
 (c) 1
 77 $(3\sqrt{5} - 2\sqrt{2})\vec{i} + (4\sqrt{2} - 3\sqrt{5})\vec{j}$
 79 $\frac{4\sqrt{2}}{6\vec{i} + 2\vec{j}}$
 81 $5/\sqrt{2}$
 83 (a) P, Q



- (c) $\|\text{grad } f\|$
 $f_u = \|\text{grad } f\| \cos \theta$
 89 $f_u(0, 0)$ is scalar, not vector
 91 Closer contours give longer gradients
 93

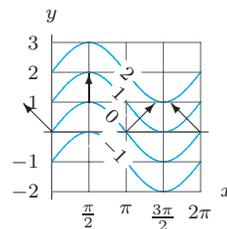


- 95 False
 97 False
 99 True
 101 False
 103 True
 105 True
 107 True
 109 True
 111 False

Section 14.5

- 1 $2x\vec{i}$
 3 $e^x e^y e^z (\vec{i} + \vec{j} + \vec{k})$
 5 $\frac{-2xyz^2}{(1+x^2)^2} \vec{i} + \frac{z^2}{1+x^2} \vec{j} + \frac{2yz}{1+x^2} \vec{k}$
 7 $(x\vec{i} + y\vec{j} + z\vec{k}) / \sqrt{x^2 + y^2 + z^2}$
 9 $y\vec{i} + x\vec{j} + e^z \cos(e^z) \vec{k}$

- 11 $e^p \vec{i} + (1/q)\vec{j} + 2re^{r^2} \vec{k}$
 13 $\vec{0}$
 15 $6\vec{i} + 4\vec{j} - 4\vec{k}$
 17 $-\pi\vec{i} - \pi\vec{k}$
 19 $9/\sqrt{3}$
 21 $-1/\sqrt{2}$
 23 $-\sqrt{77/2}$
 25 $-2\vec{i} - 2\vec{j} + 4\vec{k}$;
 $-2(x + 1) - 2(y - 1) + 4(z - 2) = 0$
 27 $2\vec{j} - 4\vec{k}$; $2(y - 1) - 4(z - 2) = 0$
 29 $-2\vec{i} + \vec{k}$; $-2(x + 1) + (z - 2) = 0$
 31 (a) 0
 (b) $24/\sqrt{19}$
 33 (a) $(2x - yz)\vec{i} + (2y - xz)\vec{j} - xy\vec{k}$
 (b) $x + 4y + 6z = 20$
 35 $z = 12 - 4x - 2y$
 37 $6(x - 1) + 3(y - 2) + 2(z - 1) = 0$
 39 $2x + 3y + 2z = 17$
 41 $z = 2x + y + 3$
 43 $x + 4y + 10z = 18$
 45 (a) is (III); (b) is (I); (c) is (IV); (d) is (II)
 47 $22/\sqrt{14}$
 49 (a) Spheres centered at the origin
 (b) $2x \sin(x^2 + y^2 + z^2) \vec{i} + 2y \sin(x^2 + y^2 + z^2) \vec{j} + 2z \sin(x^2 + y^2 + z^2) \vec{k}$
 (c) $0, 180^\circ$
 51 (a) $-\vec{j}$;
 $\frac{2}{3}\vec{i} - \frac{1}{3}\vec{j} + \frac{2}{3}\vec{k}$
 (b) $y = 0$; $2x - y + 2z = 3$
 (c) $x = y = 0$ and $z \neq 0$
 53 (a) $1.2x + 1.6y + 6z = 8$
 (b) Yes; $\pm(0.8, 0.6, 1)$
 55 (a)



- (b) Valley
 57 (a) $-4\vec{i} + 4\vec{j} + 2\vec{k}$
 (b) $24 \text{ mg/cm}^3/\text{sec}$
 59 $f_{u_3} < f_{u_2} < 0 < f_{u_4} < f_{u_1}$
 61 (a) Spheres centered at origin
 (b) $(-2x\vec{i} - 2y\vec{j} - 2z\vec{k})e^{-(x^2+y^2+z^2)}$
 (c) $-3\sqrt{2}e^{-1}$ degrees/sec
 63 (a) is (V); (b) is (IV); (c) is (V)
 71 $f_x(0, 0, 0)x + f_y(0, 0, 0)y + f_z(0, 0, 0)z = 0$
 73 $f(x, y, z) = 2x + 3y + 4z + 100$
 75 False
 77 False
 79 (a) $^\circ\text{C per meter}$
 (b) $^\circ\text{C per second}$
 (c) $^\circ\text{C per second}$

Section 14.6