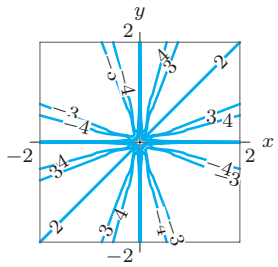
7 None

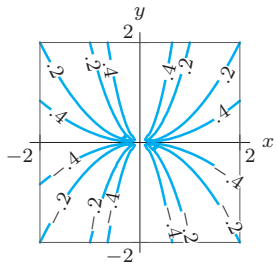
9 $(1, 2)$

11 (a)



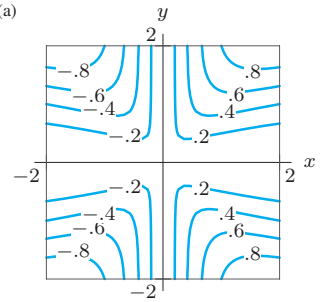
(b) No
(c) No
(d) No
(e) Exist, not continuous

13 (a)



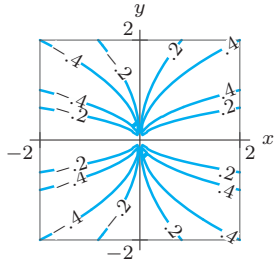
(b) Yes
(c) Yes
(d) No
(e) Exist, not continuous

15 (a)



(b) Yes
(d) No
(f) No

17 (a)



(c) No, no

19 (a) $f_x(x, y) = (x^4y + 4x^2y^3 - y^5)/(x^2 + y^2)^2$
$f_y(x, y) = (x^5 - 4x^3y^2 - xy^4)/(x^2 + y^2)^2$
(c) Yes
(d) Yes

21 Counterexample: $\sqrt{x^2 + y^2}$

23 $f(x, y) = \sqrt{x^2 + y^2}$

25 (a) Differentiable
(b) Not differentiable
(c) Not differentiable
(d) Differentiable

Chapter 14 Review

1 Vector; $3e^{-1}\vec{i} - \frac{1}{2}e^{-1}\vec{j}$

3 Vector; $-(\sin x)e^y\vec{i} + (\cos x)e^y\vec{j} + \vec{k}$

5 $f_x = 2xy + 3x^2 - 7y^6$
$f_y = x^2 - 42xy^5$

7 $\pi/\sqrt{lg}$

9 $f_x = \frac{2xy^3}{(x^2+y^2)^2}$, $f_y = \frac{x^4-x^2y^2}{(x^2+y^2)^2}$

11 $\partial f/\partial p = (1/q)e^{p/q}$
$\partial f/\partial q = -(p/q^2)e^{p/q}$

13 $f_N = c\alpha N^{\alpha-1}V^{\beta}$

15 $x/\left(2\sqrt{\omega x}\cos^2\left(\sqrt{\omega x}\right)\right)$

17 $\dfrac{270x^3y^7 - 168x^2y^6 - 15xy^2 + 16y}{(15xy - 8)^2}$

19 $\pi xy/\sqrt{2\pi xyw - 13x^7y^3v}$

21 $\frac{7}{2}\left(\frac{w-1}{x^2yw - xy^3w^7}\right)^{-9/2}$
$\left(\frac{x^2y+6xy^3w^7-7xy^3w^6}{(w-1)^2}\right)$

23 $-1/(4\pi L\sqrt{LC})$

25 $u_{xx} = e^x \sin y, \quad u_{yy} = -e^x \sin y$

27 $f_{xxy} = f_{yxx} = 2\cos(x - 2y)$

29 $2x\vec{i} + (2y + 3y^2)\vec{j}$

31 $-((1/x)\vec{i} + (1/y)\vec{j} + (1/z)\vec{k})/(xyz)$

33 $\nabla z = 2x\cos(x^2 + y^2)\vec{i}$
$+ 2y\cos(x^2 + y^2)\vec{j}$

35 $\cos(x^2 + y^2 + z^2)\left(2x\vec{i} + 2y\vec{j} + 2z\vec{k}\right)$

37 $-\frac{(t^2-2t+4)}{(2s\sqrt{s})}\vec{i} + \frac{(2t-2)}{\sqrt{s}}\vec{j}$

39 $y[\cos(xy) - \sin(xy)]\vec{i}$
$+ x[\cos(xy) - \sin(xy)]\vec{j}$

41 $2\vec{i} + \vec{k}$

43 -1

45 0

47 $2/\sqrt{3}$

49 $5\vec{i} + 4\vec{j} + 3\vec{k}$

51 $-4x - 3y + 4z = 9$

53 $x + y + z = 3$

55 $\cos t \sin(\cos t) - \sin^2 t \cos(\cos t)$

57 $100t^3$

59 $3/t + 2t/(t^2 + 1)$

61 $Q(x, y) = 2 + 6x + y + 6x^2 + 3xy$

63 $Q(x, y) = 1 + (x - 3) - \frac{1}{2}(y - 5)$
$-\frac{1}{2}(x-3)^2 + \frac{1}{2}(x-3)(y-5) - \frac{1}{8}(y-5)^2$

65 (a) $2x - 4y + az = a - 2$
(b) $a = 2$

67 (a) Q, R
(b) Q, P
(c) P, Q, R, S
(d) None

71 $F = 684$ newtons,
$\partial F/\partial m = 9.77$ newtons/kg,
$\partial F/\partial r = -0.000214$ newtons/meter

73 (a) 20 hours per day
(b) 18.615 hours per day

75 (a) P, S
(b) R, S
(c) P, Q, R, S
(d) None

77 0.3

79 0.8

81 0

83 (a) $-5\sqrt{2}/2$
(b) $4\vec{i} + \vec{j}$

85 (a) 98.387 ft/mile
(b) 295.161 ft/hour

87 (a) $-4e^{-81}$ °C/meter
(b) $-40e^{-81}$ °C/sec
(c) $\sqrt{932}e^{-81}$ °C/meter

89 $-2x\vec{i} - 2y\vec{j}$

91 Yes

95 (a) $F_u(x, y, 3)$
(b) $F_w(3, y, x)$
(c) $F_u(x, y, x) + F_w(x, y, x)$
(d) $F_u(x, y, xy) + yF_w(x, y, xy)$

97 $dP \approx 47.6\,dL + 17.8\,dK$

101 (a) $-3\vec{i} + 4\vec{j} - \vec{k}$
(b) $-3\vec{i} + 4\vec{j}$

105 15°C/minute

107 Approx 7.5 at $(1.94, 1.08)$

109 $x - y$

111 (a) Negative, positive,
Up if positive, down if negative
(b) $\pi < t < 2\pi$
(c) $0 < x < 3\pi/2$ and
$0 < t < \pi/2$ or $3\pi/2 < t < 5\pi/2$

113 (a) $A_0 + A_1 + 2A_2 + A_3 + 2A_4 + 4A_5 + (A_1 + 2A_3 + 2A_4)(x - 1) + (A_2 + A_4 + 4A_5)(y - 2), 1 + B_1t, 2 + C_1t$
(b) $A_1B_1 + 2A_3B_1 + 2A_4B_1 + A_2C_1 + A_4C_1 + 4A_5C_1$

115 $\frac{\partial w}{\partial x}\frac{\partial x}{\partial u}\frac{du}{dt} + \frac{\partial w}{\partial y}\frac{\partial y}{\partial u}\frac{du}{dt} + \frac{\partial w}{\partial x}\frac{\partial x}{\partial v}\frac{dv}{dt} + \frac{\partial w}{\partial y}\frac{\partial y}{\partial v}\frac{dv}{dt} + \frac{\partial w}{\partial z}\frac{dz}{dt}$

Section 15.1

1 (I) and (V) Local maximum, (II) and (VI) Local minimum, (III) and (IV) Saddle point

3 (a) None
(b) E, G
(c) D, F

5 Local minimum

7 Local maximum

9 Local max: $(4, 2)$

11 Local max: $(1, 5)$

13 Saddle point: $(0, 0)$
Saddle point: $(2, 0)$
Local min: $(1, 0.25)$

15 Saddle pts: $(1, -1), (-1, 1)$
Local max: $(-1, -1)$
Local min: $(1, 1)$

17 Local max: $(-1, 0)$

Saddle pts: $(1, 0), (-1, 4)$
Local min: $(1, 4)$

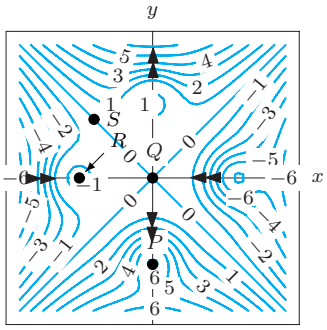
19 Saddle point: $(0, 0)$
Local max: $(1, 1), (-1, -1)$

21 $A = -2, B = 21$

23 (a) (a, b)
(b) $a = -1, b = 5$
(c) Local maximum

25 (a) Local maximum
(b) Saddle point
(c) Local minimum
(d) None of these

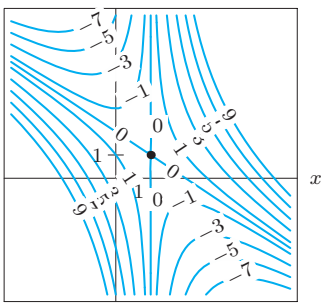
27



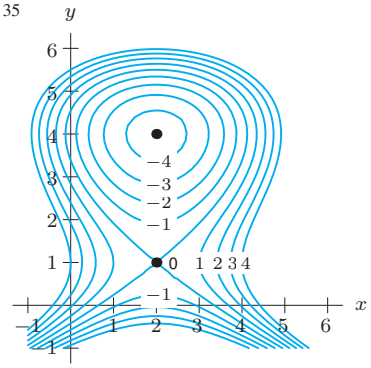
29 $(k\pi, l\pi)$,
for $k = 0, \pm1, \pm2, \cdots$,
$l = 0, \pm1, \pm2, \cdots$
$(k\pi + \frac{\pi}{2}, l\pi + \frac{\pi}{2})$,
for $k = 0, \pm1, \pm2, \cdots$,
$l = 0, \pm1, \pm2, \cdots$
$(k\pi, l\pi)$, $k = 0, \pm1, \pm2, \cdots$,
$l = 0, \pm1, \pm2, \cdots$ are saddle points
If k and l are both even or k and l are both odd, then $(k\pi + \frac{\pi}{2}, l\pi + \frac{\pi}{2})$ are local max
If k is even but l is odd or k is odd but l is even, then $(k\pi + \frac{\pi}{2}, l\pi + \frac{\pi}{2})$ are local min

31 $y = 0, \pm2\pi, \pm4\pi, \ldots$ Local minima

33 (a) (a, b) is a saddle point.
(b)

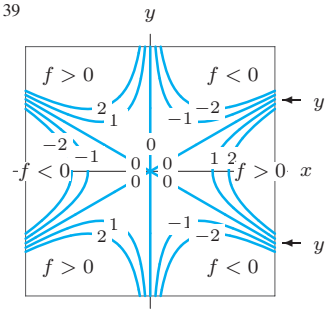


35



37 (a) $(0, 0)$
(b) $D = -24x^2$
(c) Saddle point

39



41 $(1, 3)$ could be saddle point

43 Can be saddle if f_{xy} large

45 $f(x, y) = 4 - (x - 2)^2 - (y + 3)^2$

47 False

49 True

51 False

53 True

55 False

Section 15.2

1 Mississippi:
$87 - 88$ (max), $83 - 87$ (min)
Alabama:
$88 - 89$ (max), $83 - 87$ (min)
Pennsylvania:
$89 - 90$ (max), 80 (min)
New York:
$81 - 84$ (max), $74 - 76$ (min)
California:
$100 - 101$ (max), $65 - 68$ (min)
Arizona:
$102 - 107$ (max), $85 - 87$ (min)
Massachusetts:
$81 - 84$ (max), 70 (min)

3 Max: 30.5 at $(0, 0)$
Min: 20.5 at $(2.5, 5)$

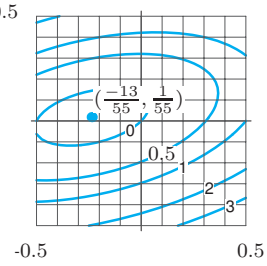
5 Min $= 0$ at $(0, 0)$
(not on boundary)
Max $= 2$ at $(1, 1), (1, -1)$, $(-1, -1)$ and $(-1, 1)$
(on boundary)

7 max$= 1$ at $(1, 0)$ and $(-1, 0)$
(on boundary)
min$= -1$ at $(0, 1), (0, -1)$
(on boundary)

9 Global min

11 Global max $= 0$
No global min

13 (a) Local min: $(-13/55, 1/55)$
(b)



15 All edges $(32)^{1/3}$ cm

17 $l = w = h = 45$ cm

19 $(3/14, 1/7, 1/14)$

23 $q_1 = 300, q_2 = 225.$

25 (a) $L = \left[pA\left(\frac{a}{k}\right)^a\left(\frac{1}{b}\right)^{(a-1)}\right]^{1/(1-a-b)}$
$K = \frac{la}{kb}L$
(b) No

27 $y = 24x^2/49 - 2/7$

31 (a) $p = \sqrt{P_0 P_F}$
(b) $p_1 = \sqrt[3]{P_0^2 P_F}, p_2 = \sqrt[3]{P_0 P_F^2}$

33 Must have global maximum if continuous and R closed, bounded

35 Local max not necessarily global max

37 $f(x, y) = x^2 + y^2$, R is $0 \le x, y \le 1$

39 False

41 False

43 False

45 True

Section 15.3

1 Min $= -\sqrt{2}$, max $= \sqrt{2}$

3 Max: 20 at $(-1, 2)$;
Min: 0 at $(1, -2)$

5 Min $= -22$, max $= 22$

7 Global min: $1/2$
No global max

9 Min $= -\sqrt{35}$, max $= \sqrt{35}$

11 Max: 4 at $(2, 2, 1), (2, -2, -1)$, $(-2, 2, -1), (-2, -2, 1)$;
Min: -4 at $(-2, -2, -1), (-2, 2, 1)$, $(2, -2, 1), (2, 2, -1)$

13 Max $= f(\frac{1}{\sqrt{5}}, \frac{3}{\sqrt{5}}) = 2\sqrt{5}$
Min $= f(-\frac{1}{\sqrt{5}}, -\frac{3}{\sqrt{5}}) = -2\sqrt{5}$

15 No global extrema

17 Max: $30 + \sqrt{10}$ at $(0, -\sqrt{10})$;
Min: -5 at $(\pm3, -1)$

19 1 at $(1/2, 1/2)$

21 0.5