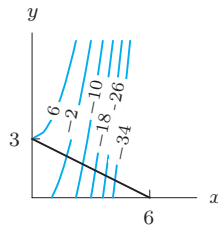


- 23 (a)  $s = 1000 - 10l$
- 25 (a) Min; max at endpt of constraint  
 $\lambda$  neg
- (b) Max; min at endpt of constraint  
 $\lambda$  pos
- 27  $\Delta c/4; -\Delta c/4$
- 31 (a)  $C = \$4349$
- (b) \$182
- 33 (a)  $W = 225$   
 $K = 37.5$
- (c)  $W = 225$   
 $K = 37.5$   
 $\lambda = 0.29$

- 35 (a) No
- (b) Yes
- (c)  $a + b = 1$
- 37  $x_1 = ((v_1)^{1/2} + (v_2)^{1/2}) / (m(v_1)^{1/2})$   
 $x_2 = ((v_1)^{1/2} + (v_2)^{1/2}) / (m(v_2)^{1/2})$
- 39 (a)  $f_1 = \frac{k_1}{k_1+k_2}mg, f_2 = \frac{k_2}{k_1+k_2}mg$
- (b) Distance the mass stretches the top spring and compresses the lower spring
- 43 (a) Cost of producing quantity  $u$  when prices are  $p, q$
- (b)  $2\sqrt{pq}u$
- 45 (a)  $-5\lambda^2 + 15\lambda$
- (b) 1.5, 11.25
- (c) 11.25, 1.5
- (d) same
- 47 (a)  $S = \ln(a^a(1-a)^{(1-a)}) + \ln b - a \ln p_1 - (1-a) \ln p_2$
- (b)  $b = e^c p_1^a p_2^{(1-a)} / (a^a(1-a)^{(1-a)})$
- 49 Maximum value is 1
- 51  $f(x, y) = 3x + 4y$
- 53  $f(x, y) = x^2 + y^2$
- 55

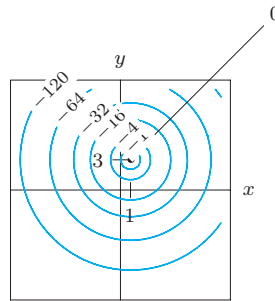


- 59 False
- 61 False
- 63 False
- 65 False
- 67 True
- 69 True

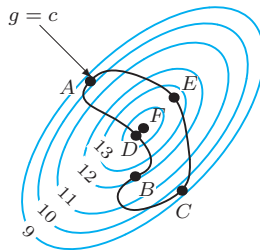
**Chapter 15 Review**

- 1 (3, -1), Saddle point

- 3 Saddle pt: (0, -5)  
Local min: (2, -5)
- 5 (2, 1); local min
- 7 (2, 3): Local and global max
- 9 Local minimum: (1, 2)  
Local maximum: (-1, -2)  
Saddle points: (1, -2) and (-1, 2)  
No global maximum or minimum
- 11 Minimum  $f(-3/\sqrt{5}, 4/\sqrt{5}) = -5\sqrt{5}$ ,  
Maximum  $f(3/\sqrt{5}, -4/\sqrt{5}) = 5\sqrt{5}$
- 13 Min = 11.25; no max
- 15 Minimum  $f(27.907, 23.256) = 1860.484$ ;  
No maximum
- 17 Maximum =  $f(48, 52) = 37,600$   
No minimum
- 19 Max = 21, no min
- 21 No global extrema.
- 23 Maximum
- 25 Both
- 27 0.204
- 29  $\Delta c/2; \Delta c/(2\sqrt{2})$
- 31



- 33 (a) (i) Power function  
(ii) Linear function
- (b)  $\ln N = 1.20 + 0.32 \ln A$   
Agrees with biological rule
- 35 (a)  $2c^2/3$
- (b)  $4c/3$
- (c)  $\lambda = m'(c)$
- 37  $c \left( \frac{aK}{(a+b)P_1} \right)^a \left( \frac{bK}{(a+b)P_2} \right)^b$
- 39 (a) Points A, B, C, D, E
- (b) Point F
- (c) Point D



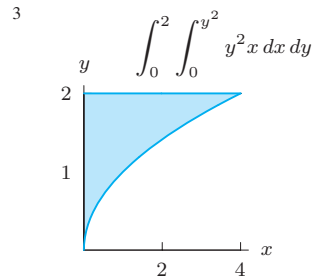
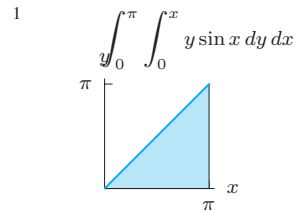
- 41  $f(x, y, z) = \frac{|Aa+Bb+Cc+D|}{\sqrt{A^2+B^2+C^2}}$
- 43  $K = 20$   
 $L = 30$   
 $C = \$7,000$

- 47 Base: 4 cm by 4 cm  
Height: 2 cm
- 49  $-1/2$
- 51 (a)  $x = 1/4 - a, y = 1$ , saddle point
- 53 (a) 21.0208
- (b)  $g = 20.5, 21.2211; g = 20.2, 21.1008$
- (c)  $g = 20.5, 21.2198; g = 20.2, 21.1007$

**Section 16.1**

- 1 24; 43.5
- 3 Over: Approx 137  
Under: Approx 60
- 5 about 2300
- 7 Positive
- 9 Zero
- 11 Zero
- 13 Positive
- 15 25.2°C
- 17 Need  $f$  nonnegative everywhere
- 19  $f(x, y) = 5 - x - y$ ;  $R$  is square with vertices  $(\pm 1, \pm 1)$
- 21 False
- 23 False
- 25 True
- 27 True
- 29 False

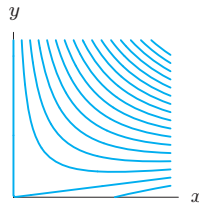
**Section 16.2**



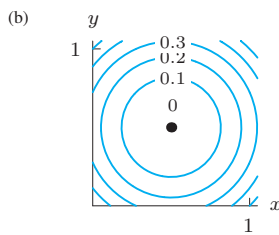
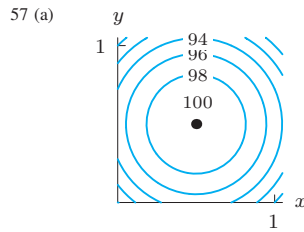
- 5 150
- 7 54
- 9  $e - 2$
- 11  $3 - \sin 3$
- 13  $(e^4 - 1)(e^2 - 1)e$
- 15 -2.678
- 17  $\int_1^4 \int_1^2 f dy dx$  or  $\int_1^2 \int_1^4 f dx dy$
- 19  $\int_{-1}^3 \int_{-2}^{(1-3x)/4} f dy dx$   
or  $\int_{-2}^1 \int_{-1}^{(1-4y)/3} f dx dy$

- 21  $\int_1^3 \int_{\frac{1}{2}(y-1)}^{-\frac{1}{2}(y-5)} f(x,y) dx dy$
- 23  $\frac{4}{15}(9\sqrt{3} - 4\sqrt{2} - 1) = 2.38176$
- 25  $32/9$
- 27  $13/6$
- 29  $0$
- 31  $2/3$
- 33  $(e - 1)/2$
- 35  $\frac{2}{9}(3\sqrt{3} - 2\sqrt{2})$

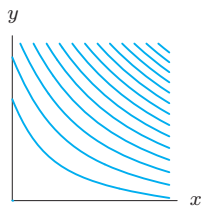
$f(x, y) = -3x^2 + 24xy:$



- 37  $\frac{1}{2}(e^2 - 1)$
- 39 (a)  $8/3$   
(b)  $16/3$
- 41 (a)  $\int_0^{1/2} \int_y^{1-y} f(x,y) dx dy$   
 $\int_0^{1/2} \int_0^x f(x,y) dy dx$   
 $\int_{1/2}^1 \int_0^{1-x} f(x,y) dy dx$   
(b)  $1/8$
- 43  $15$
- 45  $\int_{-5}^5 \int_{-\sqrt{25-y^2}}^{\sqrt{25-y^2}} (25 - x^2 - y^2) dx dy$
- 47  $\int_0^4 \int_{y-4}^{(4-y)/2} (4 - 2x - y) dx dy$
- 49  $1/3$
- 51  $16/3$
- 53 Volume =  $1/(6abc)$
- 55 (a) Circles centered at  $(1, 0)$   
(b)  $\int_{-\sqrt{3}}^{\sqrt{3}} e^{-y^2} dy$   
(c)  $\int_{-2}^2 \int_{-\sqrt{4-x^2}}^{\sqrt{4-x^2}} e^{-(x-1)^2 - y^2} dy dx$



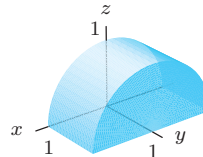
- 59 (a)  $(4/3)a + b + (4/3)c = 20$   
(b)  $f(x, y) = x^2 + \frac{44}{3}xy + 3y^2:$



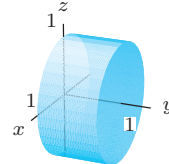
- 61  $k(a^3b + ab^3)/3$
- 63 Integrals not over same region
- 65  $\int_{-1}^1 \int_{-\sqrt{1-x^2}}^{\sqrt{1-x^2}} 2 dx dy$
- + 67  $\int_0^2 \int_0^{6-3y} 1 dx dy$
- 69 False
- 71 False
- 73 False
- 75 False

**Section 16.3**

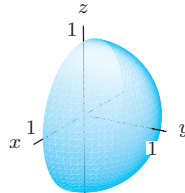
- 1  $2$
- 3  $-8$
- 5



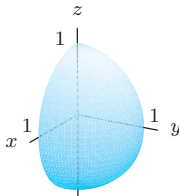
7



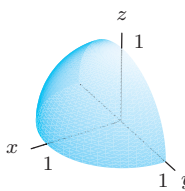
9



11



13



- 15 Positive
- 17 Positive
- 19 Zero
- 21 Positive
- 23 Zero
- 25 Positive
- 27 Positive
- 29 125

- 31 (a)  $2 \int_0^{10} \int_0^1 \int_y^1 e^{-3x} dz dy dx$   
Other answers are possible  
(b)  $(1 - e^{-30})/3$

33  $V = \int_0^1 \int_0^2 \int_{x+y}^{1+2x+2y} 1 dz dy dx$   
Can reverse order  $x, y$

35  $V = \int_0^1 \int_0^{1-x} \int_{6-3x-4y}^{6-2x-2y} 1 dz dy dx$   
Can reverse order  $x, y$

37  $V = \int_{-\sqrt{5}}^{\sqrt{5}} \int_{-\sqrt{5-x^2}}^{\sqrt{5-x^2}} \int_2^{\sqrt{9-x^2-y^2}} 1 dz dy dx$   
Can reverse order  $x, y$

39  $\int_0^1 \int_{-r}^r \int_0^{\sqrt{r^2-x^2}} f(x, y, z) dz dy dx$

41  $\int_{-r}^r \int_{-\sqrt{r^2-x^2}}^{\sqrt{r^2-x^2}} \int_0^{\sqrt{r^2-x^2-y^2}} f(x, y, z) dy dz dx$

43  $1/2$

45  $162$

47  $1$

49  $29 \text{ gm}$

51  $243$

53 (a)  $x + y + z = 1$

(b)  $1/6$

55  $\int_0^2 \int_0^{1-\frac{z}{2}} \int_0^{2-2y-\frac{z}{2}} f(x, y, z) dx dy dz$

57  $\int_{-4}^4 \int_{-\sqrt{16-x^2}}^{\sqrt{16-x^2}} \int_3^{\sqrt{25-x^2-y^2}} dz dy dx$

59  $\int_{-1}^1 \int_{-\sqrt{1-x^2}}^{\sqrt{1-x^2}} \int_{-\sqrt{1-z^2}}^{\sqrt{1-z^2}} dy dz dx$

61  $\int_0^2 \int_0^{6y^2} \int_0^{\sqrt{12-3y^2}} f(x, y, z) dx dz dy$

63  $4$

65  $m = 2;$

$(\bar{x}, \bar{y}, \bar{z}) = (13/24, 13/24, 25/24)$

67  $5m/3$

71 Need same limits on innermost integral

73  $f(x, y, z) = z$

75 True

77 True

79 False

81 True

83 True

**Section 16.4**

1  $\int_0^{\pi/2} \int_0^{1/2} f(r) r dr d\theta$

3  $\int_{\pi/4}^{3\pi/4} \int_0^2 f(r) r dr d\theta$