Appendix

TABLES

Table I Trigonometric Functions

Degrees	Radians	Sin	Tan	Cot	Cos		
0	.000	.000	.000		1.000	1.571	90
1	.017	.017	.017	57.29	1.000	1.553	89
2	.035	.035	.035	28.64	.999	1.536	88
3	.052	.052	.052	19.081	.999	1.518	87
4	.070	.070	.070	14.301	.998	1.501	86
5	.087	.087	.087	11.430	.996	1.484	85
6	.105	.105	.105	9.514	.995	1.466	84
7	.122	.122	.123	8.144	.993	1.449	83
8	.140	.139	.141	7.115	.990	1.431	82
9	.157	.156	.158	6.314	.988	1.414	81
10	.175	.174	.176	5.671	.985	1.396	80
11	.192	.191	.194	5.145	.982	1.379	79
12	.209	.208	.213	4.705	.978	1.361	78
13	.227	.225	.231	4.331	.974	1.344	77
14	.244	.242	.249	4.011	.970	1.326	76
15	.262	.259	.268	3.732	.966	1.309	75
16	.279	.276	.287	3.487	.961	1.292	74
17	.297	.292	.306	3.271	.956	1.274	73
18	.314	.309	.325	3.078	.951	1.257	72
19	.332	.326	.344	2.904	.946	1.239	71
20	.349	.342	.364	2.747	.940	1.222	70
21	.367	.358	.384	2.605	.934	1.204	69
22	.384	.375	.404	2.475	.927	1.187	68
23	.401	.391	.424	2.356	.921	1.169	67
24	.419	.407	.445	2.246	.914	1.152	66
		Cos	Cot	Tan	Sin	Radians	Degrees

(Table I is continued on the next page.)

Table I Trigonometric Functions (continued)

Degrees	Radians	Sin	Tan	Cot	Cos		
25	.436	.423	.466	2.144	.906	1.134	65
26	.454	.438	.488	2.050	.899	1.117	64
27	.471	.454	.510	1.963	.891	1.100	63
28	.489	.469	.532	1.881	.883	1.082	62
29	.506	.485	.554	1.804	.875	1.065	61
30	.524	.500	.577	1.732	.866	1.047	60
31	.541	.515	.601	1.664	.857	1.030	59
32	.559	.530	.625	1.600	.848	1.012	58
33	.576	.545	.649	1.540	.839	.995	57
34	.593	.559	.675	1.483	.829	.977	56
35	.611	.574	.700	1.428	.819	.960	55
36	.628	.588	.727	1.376	.809	.942	54
37	.646	.602	.754	1.327	.799	.925	53
38	.663	.616	.781	1.280	.788	.908	52
39	.681	.629	.810	1.235	.777	.890	51
40	.698	.643	.839	1.192	.766	.873	50
41	.716	.656	.869	1.150	.755	.855	49
42	.733	.669	.900	1.111	.743	.838	48
43	.750	.682	.933	1.072	.731	.820	47
44	.768	.695	.966	1.036	.719	.803	46
45	.785	.707	1.000	1.000	.707	.785	45
		Cos	Cot	Tan	Sin	Radians	Degrees

Table II Greek Alphabet

A α	Alpha	N ν	Nu
B β	Beta	Ξ ξ	Xi, Si
Γ γ	Gamma	O o	Omicron
Δ δ	Delta	Π π	Pi
E ε	Epsilon	P ρ	Rho
Z ζ	Zeta	Σ σ	Sigma
H η	Eta	T τ	Tau
Θ θ	Theta	Υ υ	Upsilon
I ι	Iota	Φ ϕ	Phi
K κ	Kappa	X χ	Chi
Λ λ	Lambda	Ψ ψ	Psi
M μ	Mu	Ω ω	Omega

Table III Exponential Functions

x	e^x	e^{-x}
0.0	1.00	1.00
0.1	1.11	.905
0.2	1.22	.819
0.3	1.35	.741
0.4	1.49	.670
0.5	1.65	.607
0.6	1.82	.549
0.7	2.01	.497
0.8	2.23	.449
0.9	2.46	.407
1.0	2.72	.368
1.1	3.00	.333
1.2	3.32	.301
1.3	3.67	.273
1.4	4.06	.247
1.5	4.48	.223
1.6	4.95	.202
1.7	5.47	.183
1.8	6.05	.165
1.9	6.69	.150
2.0	7.39	.135
2.1	8.17	.122
2.2	9.02	.111
2.3	9.97	.100
2.4	11.0	.091
2.5	12.2	.082
2.6	13.5	.074
2.7	14.9	.067
2.8	16.4	.061
2.9	18.2	.055

x	e^x	e^{-x}
3.0	20.1	.050
3.1	22.2	.045
3.2	24.5	.041
3.3	27.1	.037
3.4	30.0	.033
3.5	33.1	.030
3.6	36.6	.027
3.7	40.4	.025
3.8	44.7	.022
3.9	49.4	.020
4.0	54.6	.018
4.1	60.3	.017
4.2	66.7	.015
4.3	73.7	.014
4.4	81.5	.012
4.5	90.0	.011
4.6	99.5	.010
4.7	110	.0091
4.8	122	.0082
4.9	134	.0074
5.0	148	.0067
5.1	164	.0061
5.2	181	.0055
5.3	200	.0050
5.4	221	.0045
5.5	245	.0041
5.6	270	.0037
5.7	299	.0033
5.8	330	.0030
5.9	365	.0027
6.0	403	.0025

Table IV Natural Logarithms

n	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0*		7.697	8.391	8.796	9.084	9.307	9.489	9.643	9.777	9.895
1	0.000	0.095	0.182	0.262	0.336	0.405	0.470	0.531	0.588	0.642
2	0.693	0.742	0.788	0.833	0.875	0.916	0.956	0.993	1.030	1.065
3	1.099	1.131	1.163	1.194	1.224	1.253	1.281	1.308	1.335	1.361
4	1.386	1.411	1.435	1.459	1.482	1.504	1.526	1.548	1.569	1.589
5	1.609	1.629	1.649	1.668	1.686	1.705	1.723	1.740	1.758	1.775
6	1.792	1.808	1.825	1.841	1.856	1.872	1.887	1.902	1.917	1.932
7	1.946	1.960	1.974	1.988	2.001	2.015	2.028	2.041	2.054	2.067
8	2.079	2.092	2.104	2.116	2.128	2.140	2.152	2.163	2.175	2.186
9	2.197	2.208	2.219	2.230	2.241	2.251	2.262	2.272	2.282	2.293
10	2.303	2.313	2.322	2.332	2.342	2.351	2.361	2.370	2.380	2.389

* Subtract 10 if $n < 1$; for example, $\ln 0.3 \approx 8.796 - 10 = -1.204$.

Table V Powers and Roots

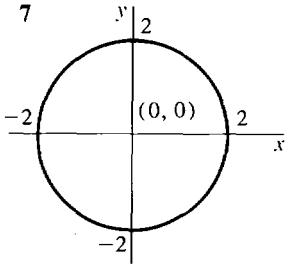
n	n^2	$\sqrt{n}$	n^3	$\sqrt[3]{n}$	n	n^2	$\sqrt{n}$	n^3	$\sqrt[3]{n}$
1	1	1.000	1	1.000	**51**	2,601	7.141	132,651	3.708
2	4	1.414	8	1.260	**52**	2,704	7.211	140,608	3.733
3	9	1.732	27	1.442	**53**	2,809	7.280	148,877	3.756
4	16	2.000	64	1.587	**54**	2,916	7.348	157,464	3.780
5	25	2.236	125	1.710	**55**	3,025	7.416	166,375	3.803
6	36	2.449	216	1.817	**56**	3,136	7.483	175,616	3.826
7	49	2.646	343	1.913	**57**	3,249	7.550	185,193	3.849
8	64	2.828	512	2.000	**58**	3,364	7.616	195,112	3.871
9	81	3.000	729	2.080	**59**	3,481	7.681	205,379	3.893
10	100	3.162	1,000	2.154	**60**	3,600	7.746	216,000	3.915
11	121	3.317	1,331	2.224	**61**	3,721	7.810	226,981	3.936
12	144	3.464	1,728	2.289	**62**	3,844	7.874	238,328	3.958
13	169	3.606	2,197	2.351	**63**	3,969	7.937	250,047	3.979
14	196	3.742	2,744	2.410	**64**	4,096	8.000	262,144	4.000
15	225	3.873	3,375	2.466	**65**	4,225	8.062	274,625	4.021
16	256	4.000	4,096	2.520	**66**	4,356	8.124	287,496	4.041
17	289	4.123	4,913	2.571	**67**	4,489	8.185	300,763	4.062
18	324	4.243	5,832	2.621	**68**	4,624	8.246	314,432	4.082
19	361	4.359	6,859	2.668	**69**	4,761	8.307	328,509	4.102
20	400	4.472	8,000	2.714	**70**	4,900	8.367	343,000	4.121
21	441	4.583	9,261	2.759	**71**	5,041	8.426	357,911	4.141
22	484	4.690	10,648	2.802	**72**	5,184	8.485	373,248	4.160
23	529	4.796	12,167	2.844	**73**	5,329	8.544	389,017	4.179
24	576	4.899	13,824	2.884	**74**	5,476	8.602	405,224	4.198
25	625	5.000	15,625	2.924	**75**	5,625	8.660	421,875	4.217
26	676	5.099	17,576	2.962	**76**	5,776	8.718	438,976	4.236
27	729	5.196	19,683	3.000	**77**	5,929	8.775	456,533	4.254
28	784	5.292	21,952	3.037	**78**	6,084	8.832	474,552	4.273
29	841	5.385	24,389	3.072	**79**	6,241	8.888	493,039	4.291
30	900	5.477	27,000	3.107	**80**	6,400	8.944	512,000	4.309
31	961	5.568	29,791	3.141	**81**	6,561	9.000	531,441	4.327
32	1,024	5.657	32,768	3.175	**82**	6,724	9.055	551,368	4.344
33	1,089	5.745	35,937	3.208	**83**	6,889	9.110	571,787	4.362
34	1,156	5.831	39,304	3.240	**84**	7,056	9.165	592,704	4.380
35	1,225	5.916	42,875	3.271	**85**	7,225	9.220	614,125	4.397
36	1,296	6.000	46,656	3.302	**86**	7,396	9.274	636,056	4.414
37	1,369	6.083	50,653	3.332	**87**	7,569	9.327	658,503	4.431
38	1,444	6.164	54,872	3.362	**88**	7,744	9.381	681,472	4.448
39	1,521	6.245	59,319	3.391	**89**	7,921	9.434	704,969	4.465
40	1,600	6.325	64,000	3.420	**90**	8,100	9.487	729,000	4.481
41	1,681	6.403	68,921	3.448	**91**	8,281	9.539	753,571	4.498
42	1,764	6.481	74,088	3.476	**92**	8,464	9.592	778,688	4.514
43	1,849	6.557	79,507	3.503	**93**	8,649	9.644	804,357	4.531
44	1,936	6.633	85,184	3.530	**94**	8,836	9.695	830,584	4.547
45	2,025	6.708	91,125	3.557	**95**	9,025	9.747	857,375	4.563
46	2,116	6.782	97,336	3.583	**96**	9,216	9.798	884,736	4.579
47	2,209	6.856	103,823	3.609	**97**	9,409	9.849	912,673	4.595
48	2,304	6.928	110,592	3.634	**98**	9,604	9.899	941,192	4.610
49	2,401	7.000	117,649	3.659	**99**	9,801	9.950	970,299	4.626
50	2,500	7.071	125,000	3.684	**100**	10,000	10.000	1,000,000	4.642

ANSWERS TO SELECTED PROBLEMS

Section 1.1

1 5 **3** $\sqrt{13}$ **5** 13

7



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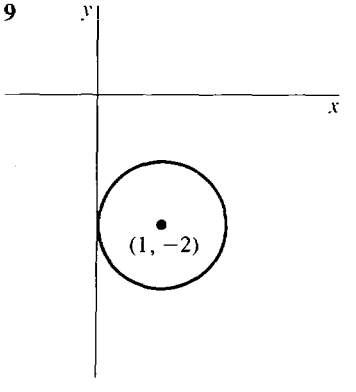

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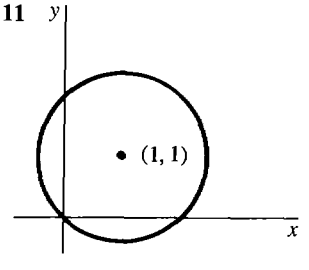


13 $(x-3)^2 + y^2 = 4$

15 $(x-1)^2 + (y-\sqrt{3})^2 = 4, (x-1)^2 + (y+\sqrt{3})^2 = 4$

17 $(x-2)^2 + (y-4)^2 = 25$

Section 1.2

	-1	$-\frac{1}{2}$	0	$\frac{1}{2}$	1
1	$-1/3$	$-1/6$	0	$1/6$	$1/3$
3	-6	$3/8$	2	$9/8$	0
5	1	$1/\sqrt{2}$	0	*	*
7	2	1	1	1	2

9 yes

11 $f(2) = 7, f(t) = 1 + t + t^2, f(t + \Delta t) = 1 + (t + \Delta t) + (t + \Delta t)^2$,
$f(1 + t + t^2) = 1 + (1 + t + t^2) + (1 + t + t^2)^2, f(g(t)) = 1 + g(t) + (g(t))^2$

13 $f(t) = t\sqrt{t}, f(t + \Delta t) = (t + \Delta t)^{3/2}, f(t^2) = |t^3|, f(\sqrt{t}) = t^{3/4}, f(g(t)) = (g(t))^{3/2}$

15 $4\,\Delta x$

17 $$\frac{1}{x^2 + 2x\,\Delta x + \Delta x^2} - \frac{1}{x^2} = -\frac{(2x + \Delta x)\,\Delta x}{x^2(x^2 + 2x\,\Delta x + \Delta x^2)}$$

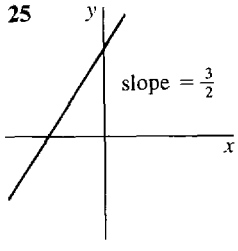
19 $$\sqrt{x + \Delta x} - \sqrt{x} = \frac{\Delta x}{\sqrt{x + \Delta x} + \sqrt{x}}$$

21 everywhere except $x = 1$ and $x = -1$ **23** $x \geq 0$ **25** $(-1, 1)$

Section 1.3

1 $m = 1, y = x + 1$ **3** vertical, $x = -4$ **5** $m = -\frac{1}{3}, y = (-\frac{1}{3})x + 1$
7 $m = 0, y = 3$ **9** $y = 2x - 3$ **11** $y = -(\frac{1}{2})x - \frac{7}{2}$ **13** $y = 5x$ **15** $y = 4$
17 $v = 2, y = 2t$ **19** $v = -\frac{1}{2}, y = -(\frac{1}{2})t + \frac{9}{2}$ **21** $v = 0, y = 4$ **23** $y + 3t + 2$

25



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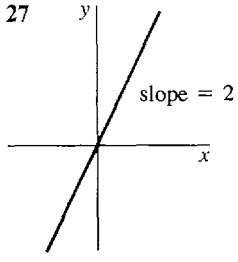

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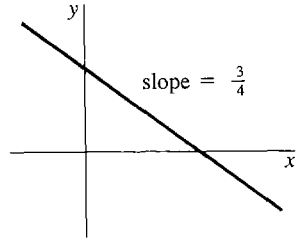


33 $(-c/a, 0), (0, -c/b)$

Section 1.4 (no problem set)

Section 1.5

1 infinitesimal **3** infinite **5** infinite **7** infinite **9** infinitesimal
11 infinitesimal **13** infinite **15** infinite **17** finite **19** finite **21** infinite
23 infinitesimal **25** infinite **27** finite **29** finite **31** finite **33** infinite
35 infinitesimal **37** infinite **39** finite

41 (a) $\varepsilon > \varepsilon^2$ (b) $1/\varepsilon^3 < 1/\varepsilon^4$ (c) $H < H^2$ (d) $\varepsilon < \sqrt{\varepsilon}$ (e) $H > \sqrt{H}$ (f) $\sqrt{H} > \sqrt[3]{H}$

43 (a) $a = 0$ and $b \neq 0$ (b) $a \neq 0$ and $b \neq 0$, or $a = b = 0$ (c) $a \neq 0$ and $b = 0$

Section 1.6

1 2 **3** 2/5 **5** $x^{1/2}$ **7** 0 **9** 2 **11** 3 **13** 0 **15** 1/2 **17** 1/2
19 $x + y$ **21** $3x^2$ **23** 10 **25** $-1/6$ **27** 1 **29** 1/2 **31** $-1/16$

33 $$\frac{1}{1 + \sqrt{2}} \text{ or } \sqrt{2} - 1$$

Extra Problems for Chapter 1

1 $\sqrt{122}$ **3** $-5/3$ **5** $y = -2x + 13$ **7** $(x-1)^2 + (y-3)^2 = 5$
9 finite **11** infinite **13** infinite **15** infinitesimal **17** 48
19 4/7 **21** $-15/4$ **23** $\dfrac{1}{\sqrt{x+\Delta x}} - \dfrac{1}{\sqrt{x}}$ **25** $A = 6V^{2/3}$

Section 2.1

1 $2x$ **3** $-4x$ **5** 4 **7** $12t^2$ **9** $5/(2\sqrt{u})$ **11** $\frac{3}{2}\sqrt{x}$ **13** $-2t^{-3}$
15 $-3y^{-2} + 4$ **17** a **19** $a/(2\sqrt{ax+b})$ **21** $2(3-2x)^{-2}$ **23** 1/4 **25** $4t^3$
27 \$600, \$0, $-$\$1000 **29** $-3x^2$ if $x \le 0$, $3x^2$ if $x > 0$.

Section 2.2

1 $\Delta y = 2x\,\Delta x + \Delta x^2, dy = 2x\,\Delta x, \Delta y = dy + \Delta x^2$
3 $\Delta y = \dfrac{2\,\Delta x}{\sqrt{x+\Delta x}+\sqrt{x}}, dy = \dfrac{\Delta x}{\sqrt{x}}, \Delta y = dy + \left[\dfrac{2}{\sqrt{x+\Delta x}+\sqrt{x}} - \dfrac{1}{\sqrt{x}}\right]\Delta x$
5 $\Delta y = -\dfrac{\Delta x}{x(x+\Delta x)}, dy = -\dfrac{\Delta x}{x^2}, \Delta y = dy + \left[\dfrac{1}{x^2} - \dfrac{1}{x(x+\Delta x)}\right]\Delta x$
7 $\Delta y = \left(1 + \dfrac{1}{x(x+\Delta x)}\right)\Delta x, dy = \left(1 + \dfrac{1}{x^2}\right)\Delta x, \Delta y = dy + \left[\dfrac{1}{x(x+\Delta x)} - \dfrac{1}{x^2}\right]\Delta x$
9 $\Delta y = 4x\,\Delta x + 2\,\Delta x^2, \Delta z = 3x^2\,\Delta x + 3x\,\Delta x^2 + \Delta x^3, dy = 4x\,dx, dz = 3x^2\,dx$ **11** $2\,dx$
13 $dx/(2\sqrt{x+1})$ **15** $a\,dx$ **17** $(-2/x^2)\,dx$ **19** $-\frac{1}{2}x^{-3/2}\,dx$
21 $d(y+z) = \left(\dfrac{1}{2\sqrt{x}} + 3\right)dx, d\left(\dfrac{y}{z}\right) = -\dfrac{1}{6}x^{-3/2}$ **23** $y = 4x - 4$ **25** $y = 0$
27 $y = 3x - 4$ **29** $y = -32x - 48$ **31** $y = (2x_0)x - x_0^2$

Section 2.3

1 $6x + 5$ **3** $5(x+8)^4$ **5** $-3(4-t)^2$ **7** $6x(x^2+5)^2$ **9** $-12x(6-2x^2)^2$
11 $24x^2(1-4x^3)^{-3}$ **13** $5(1+x^{-2})$ **15** $-8(4x-1)(2x^2-x+3)^{-3}$
17 $t^{-2}(1+t^{-1})^{-2}$ or $(t+1)^{-2}$ **19** $3(8t-2)(4t^2-2t+1)^{-2}$ **21** $-3x^2 + 5x - 1$
23 $6(3t^2+1)(2t-4)^2 + 6t(2t-4)^3$ or $6(2t-4)^2(5t^2-4t+1)$ **25** $-2(x-1)^{-2}$
27 $4x(x^2+1)^{-2}$ **29** $(s^2-6s+7)(s-3)^{-2}$ **31** $-5(3x-4)^{-2}$ **33** 0
35 $6(x^2+1)(2x^2-1) + 12x(x^2+1)(2x+3) + 6x(2x^2-1)(2x+3)$
37 $-(4x-5)(2x+1)^{-2}(x-3)^{-2}$ **39** $2(2x+1)^{-2}[(2x+1)^{-1}+3]^{-2}$
41 $4x(2x+1)^3(x^2+1) + 6(2x+1)^2(x^2+1)^2$ or $2(2x+1)^2(x^2+1)(7x^2+2x+3)$
43 $\dfrac{dy}{dx} = \dfrac{du}{dx} - \dfrac{dv}{dx}$ **45** $\dfrac{dy}{dx} = 4\dfrac{du}{dx} + 2v\dfrac{dv}{dx}$ **47** $\dfrac{dy}{dx} = -\left[u\dfrac{dv}{dx} + v\dfrac{du}{dx}\right](uv)^{-2}$
49 $y = 6x - 2$ **51** $b = -2, c = 4$

Section 2.4

1 $(9y^2+2)^{-1}$ **3** $-\frac{1}{4}y^{-1}$ **5** $-\frac{1}{2}y^{-1}(y^2+2)^2$ or $-1/(2x^2y)$ **7** $\frac{4}{3}x^{1/3}$
9 $-\dfrac{1}{\sqrt{x}(\sqrt{x}-1)^2}$ **11** $\frac{2}{3}x^{-2/3} + \frac{8}{3}x^{-1/3} + 6$ **13** $-2(\frac{5}{3}x^{2/3} - 1)(x^{5/3} - x)^{-3}$
15 $(y^{-2/3}+2)^{-1}$ **17** $y = \dfrac{1}{k}(x-c), \dfrac{dy}{dx} = \dfrac{1}{k}$ **19** $y = \sqrt{\dfrac{x-1}{2}}, \dfrac{dy}{dx} = \dfrac{1}{2\sqrt{2}\sqrt{x-1}}$
21 $y = (x+3)^{1/4}, \dfrac{dy}{dx} = \dfrac{1}{4}(x+3)^{-3/4}$.

23 $y = \left[\dfrac{\sqrt{4x-3}-1}{2}\right]^{1/2}$, $\dfrac{dy}{dx} = (4y^3 + 2y)^{-1}$ or $\dfrac{dy}{dx} = \dfrac{1}{2}\left[\dfrac{\sqrt{4x-3}-1}{2}\right]^{-1/2}(4x-3)^{-1/2}$

25 $y = \left[\dfrac{\sqrt{1+8x}-1}{4}\right]^2 = \dfrac{1+4x-\sqrt{1+8x}}{8}$, $\dfrac{dy}{dx} = \left(\dfrac{1}{2\sqrt{y}} + 2\right)^{-1}$ or $\dfrac{dy}{dx} = \dfrac{1}{2} - \dfrac{1}{2\sqrt{1+8x}}$

Section 2.5

1 $-2\sin\theta\cos\theta$ **3** $2\cos x - 3\sin x$ **5** $\sin z(\cos z)^{-2}$ **7** $n\sin^{n-1}\theta\cos\theta$
9 $t\cos t + \sin t$ **11** $e^x + xe^x$ **13** $(2\ln x)/x$ **15** $e^x/x + e^x\ln x$
17 $-e^v\sqrt{v} + (1-e^v)/2\sqrt{v}$ **19** $x^n/x + nx^{n-1}\ln x$
21 $y - 1/2 = (\sqrt{3}/2)(x - \pi/6)$ **23** $y = x - x/e$

Section 2.6

1 $\frac{1}{2}(x+2)^{-1/2}$ **3** $-\frac{1}{2}(5-x)^{-1/2}$ **5** $-\frac{3}{2}(2+3x)^{-3/2}$ **7** $2(6x+1)^{-2/3}$
9 $x(x^2+1)^{-1/2}$ **11** $3\cos(3x)$ **13** $-2x^{-3}\cos(x^{-2})$ **15** $4e^{4x}$
17 $-\sin x e^{\cos x}$ **19** $-e^x\sin(e^x)$ **21** $-40(1-4x)^9$
23 $-2x\cos(1-x^2) + 2\cos(2x-1)$
25 $\dfrac{e^{\sqrt{\sin x}}\cos x}{2\sqrt{\sin x}}$ **27** $-\frac{1}{3}x(1+\sqrt{x^2-1})^{-4/3}(x^2-1)^{-1/2}$
29 $-12[1+(x^3+1)^{-1}]^3x^2(x^3+1)^{-2}$
31 $\frac{1}{3}[\sqrt{x^2-1}+\sqrt{x^2+1}]^{-2/3}[x(x^2-1)^{-1/2} + x(x^2+1)^{-1/2}]$
33 $6x\cos(2x-1) + 3\sin(2x-1)$
35 $-\dfrac{\cos(3t)}{\sin(3t)}$ **37** $\dfrac{2\cos(2t)}{\cos t}$
39 $2t(t+1)$ **41** $\sqrt{t^2-4}/\sqrt{t^2+4}$
43 $(t+1)^{2/3}(t+2)^{-2/3}$ **45** $(9/2)t$

Section 2.7

1 $2x^{-3}$ **3** $-10(x+1)^{-3}$ **5** $-(1/4)x^{-3/2} + (3/4)x^{-5/2}$ **7** $(3/4)t^{-1/2}$
9 $-\sin x$ **11** $-AB^2\sin(Bx)$ **13** a^2e^{ax} **15** $-x^{-2}$
17 $-2(t^2+1)^{-2} + 8t^2(t^2+1)^{-3}$ **19** $-14(x+2)^{-3}$
21 $-\frac{1}{4}x(x+1)^{-3/2} + (x+1)^{-1/2}$ or $(\frac{3}{4}x+1)(x+1)^{-3/2}$
23 $\frac{3}{4}t^{1/2}(t+3)^{-5/2} - \frac{1}{2}t^{-1/2}(t+3)^{-3/2} - \frac{1}{4}t^{-3/2}(t+3)^{-1/2}$ or $-(3t^{-1/2} + \frac{9}{4}t^{-3/2})(t+3)^{-5/2}$
25 $-6t^{-4}$ **27** $3\dfrac{d^2u}{dx^2}$ **29** $2u\dfrac{d^2u}{dx^2} + 2\left(\dfrac{du}{dx}\right)^2$

Section 2.8

1 $-(y/x)$ **3** $-(x/y)^2$ **5** $\dfrac{-y}{2y+x}$ **7** $-(y/x)^3$ **9** $-\dfrac{2x+3y}{3x+2y}$ **11** $\dfrac{5x^4}{2y-1}$
13 $\dfrac{y}{2y-x}$ **15** $\dfrac{6xy-y^2-1}{2xy-3x^2}$ **17** $\dfrac{y\cos(xy)}{1-x\cos(xy)}$ **19** $-\dfrac{1}{2\sin y\cos y}$
21 $\dfrac{y}{1-2y}$ **23** ye^x **25** $2(6y^2+4xy-3)^{-1}$

27 at $(1, 2)$, $y' = -4/5$; at $(-1, 3)$, $y' = -1/5$
29 at $(2, 1)$, $y' = 2$; at $(2, -1)$, $y' = -2$; at $(\sqrt{3}, 0)$, vertical
31 $-2/3$ **33** e **35** $\dfrac{2x}{y}, \dfrac{2y^2 - 4x^2}{y^3}$

Extra Problems for Chapter 2

1 $12x^2 - 2$ **3** 8 **5** $\Delta y = \dfrac{1}{(x + \Delta x)^3} - \dfrac{1}{x^3} = -\dfrac{3x^2 + 3x\,\Delta x + \Delta x^2}{x^3(x + \Delta x)^3}\Delta x$, $dy = -3x^{-4}\,\Delta x$ **7** $(2x - 2x^{-3})\,dx$ **9** $y = -x$ **11** $-9x^2 - 5$
13 $9t^2 + 8t - 15$ **15** $(-2v^4 + 10v^3 - 3v^2 - 16v + 20)(v^3 - 4)^{-2}$
17 $\frac{1}{2}x^{-1/2} + 6x^{1/2}$ **19** $\frac{1}{3}x^{-2/3} + \frac{1}{4}x^{-5/4}$ **21** $(2y + \frac{1}{2}y^{-1/2})^{-1}$ or $\dfrac{2\sqrt{y}}{4y\sqrt{y} + 1}$
23 $\dfrac{-3}{2\sqrt{1 - 3x}}$ **25** $-\frac{5}{2}(5x + 4)^{-3/2}$ **27** $-(3 + \frac{1}{2}t^{-1/2})(t^{-2} + 2t)^{-1}$
29 $-4(4x - 1)^{-3/2}$ **31** $v = \dfrac{3t + 6}{2\sqrt{t + 3}}, a = \dfrac{3t + 12}{4(t + 3)^{3/2}}$ **33** $-\dfrac{3y^3 + 6x^2y}{9xy^2 + 2x^3}$
35 $f'(x) = \begin{cases} 2x & \text{if } |x| > 1 \\ \text{undefined} & \text{if } |x| = 1 \\ -2x & \text{if } |x| < 1 \end{cases}$

Section 3.1

1 $p = 4\sqrt{A}$ **3** $V = S^{3/2}/(6\sqrt{\pi})$ **5** $z = \sqrt{x^4 - x^2 + 1}$ **7** $V = (s - 2x)^2x$
9 $s = 3y/(10 - y)$, $0 < y < 10$ **11** $b/16$ **13** $A = (1 + t)(w - 2t)$
15 $P(x) = x(100 - \sqrt{x}) - 10x$ or $P(x) = x(90 - \sqrt{x})$

Section 3.2

1 100 cm^2/sec **3** -2 in.^{2}/sec **5** $10\sqrt{61}$ mph **7** 10/3 in.^{2}/sec
9 $40(3g)^{1/2}$ ft/sec where $g = 32$, or $160\sqrt{6}$ ft/sec **11** -120 mph
13 $\dfrac{800 \cdot 400}{\sqrt{(800)^2 + 6^2}} = \dfrac{160{,}000}{\sqrt{160{,}009}}$ mph **15** -2 ft/sec
17 $1{,}000{,}000t - 300{,}000\sqrt{t}$ people/year **19** \$60 per person per year
21 $(55/144)\pi$ in.^{2}/min **23** -0.01 **25** $2 - (x/500)$ **27** -100 radians/hr
29 22

Section 3.3

1 53 **3** does not exist **5** does not exist **7** $-1/(4\sqrt{2})$ **9** 1/3
11 does not exist **13** does not exist **15** 1 **17** $(1 + \sqrt{2})^{1/2}$ **19** 1
21 $-1/2$ **23** $2x$ **25** $1/(2\sqrt{t})$ **27** $3x^2$ **29** -2 **31** does not exist

Section 3.4

1 R **3** > -2 **5** R **7** all x except $x = 0, x = -1$ **9** $-2 < x < 2$
11 all x except $x = (-1 \pm \sqrt{5})/2$ and $x = -1$
13 all x except $x = 2, x = 3$ **15** $x < 1$

Section 3.5

1 0, min **3** 0, min **5** 0, neither **7** $-1/3$, min **9** 0, min **11** 0, max
13 0, neither **15** $-1/(2^{1/3})$, min **17** 3/2, min **19** 0, max **21** π, neither
23 0, max **25** 0, min **27** -1, min **29** 1, min **31** 3, min **33** 0, max
35 1/2, max **37** $1/\sqrt{17}$ at $(4/17, 1/17)$ **39** $1 - m$ at $x = 1$
41 max of 3/4 at $x = 2$, min of $-1/4$ at $x = -2$
43 max of $3/(4 \cdot 3^{1/4})$ at $x = 1/(3^{1/4})$, min of $-3/(4 \cdot 3^{1/4})$ at $x = -1/(3^{1/4})$

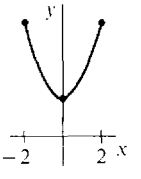
Section 3.6

1 $x = 20/3$, $y = 40/3$ **3** $x = 50$, $y = 1$ **5** $x = 3/4$, $y = 1/4$, $x^3y = 27/256$
7 width $= 10\sqrt{3}$ in., length $= 40/\sqrt{3}$ in. **9** base = height $= 1/\sqrt{2}$
11 side of square = 10/3 in., height of triangle = 10/3 in. **13** area $= r^2$
15 base of radius 2/3, height 1 **17** base of radius $4/(3\pi)$, height 4/3 **19** 50
21 $x = 50{,}000$, $p = \$5$ **23** 256 sec **25** 1/2 **27** base 4, height 2
29 $1/\sqrt{17}$ at $x = 4/17$, $y = 1/17$ **31** height $(3/2) \cdot$ side of base
33 $r = (2\pi)^{-1/3}$, $h = (4/\pi)^{1/3}$ **35** $x = (a + b)/2$
37 $A = 2/r$, dA/dr is never zero, $0 < r < \infty$ **39** $10\sqrt[3]{2}$ hours **41** 62,500

Section 3.7

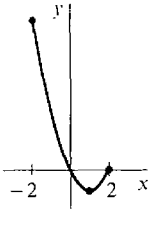
1

x	$f(x)$	$f'(x)$	$f''(x)$		
-2	6	-4	+	decr.	$\cup$
0	2	0	+	min.	$\cup$
2	6	4	+	incr.	$\cup$



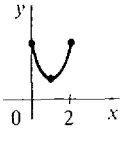
3

x	$f(x)$	$f'(x)$	$f''(x)$		
-2	8	-6	+	decr.	$\cup$
1	-1	0	+	min.	$\cup$
2	0	2	+	incr.	$\cup$



5

x	$f(x)$	$f'(x)$	$f''(x)$		
0	3	-4	+	decr.	$\cup$
1	1	0	+	min.	$\cup$
2	3	4	+	incr.	$\cup$

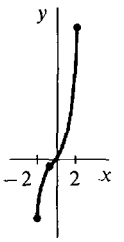


7

x	$f(x)$	$f'(x)$	$f''(x)$		
-2	16	-32	+	decr.	$\cup$
0	0	0	+	min.	$\cup$
2	16	32	+	incr.	$\cup$

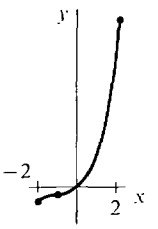
9

x	$f(x)$	$f'(x)$	$f''(x)$		
-2	-6	9	$-$	incr.	$\cap$
$-\frac{1}{3}$	$-\frac{7}{27}$	$\frac{2}{3}$	0	incr.	infl.
2	14	17	$+$	incr.	$\cup$



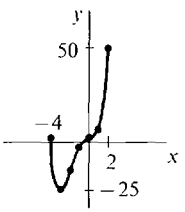
11

x	$f(x)$	$f'(x)$	$f''(x)$		
-2	$-\frac{2}{3}$	1	$-$	incr.	$\cap$
-1	$-\frac{1}{3}$	0	0	horiz.	infl.
2	$8\frac{2}{3}$	9	$+$	incr.	$\cup$



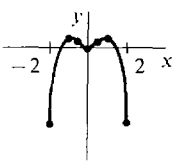
13

x	$f(x)$	$f'(x)$	$f''(x)$		
-4	2	-64	$+$	decr.	$\cup$
-3	-25	0	$+$	min.	$\cup$
-2	-14	16	0	incr.	infl.
-1	-1	8	$-$	incr.	$\cap$
0	2	0	0	horiz.	infl.
1	7	16	$+$	incr.	$\cup$
2	50	96	$+$	incr.	$\cup$



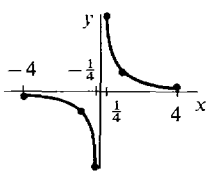
15

x	$f(x)$	$f'(x)$	$f''(x)$		
-2	-4	12	$-$	incr.	$\cap$
-1	$\frac{1}{2}$	0	$-$	max.	$\cap$
$-1/\sqrt{3}$	$\frac{5}{18}$	$-\frac{4}{3}\sqrt{3}$	0	decr.	infl.
0	0	0	$+$	min.	$\cup$
$1/\sqrt{3}$	$\frac{5}{18}$	$\frac{4}{3}\sqrt{3}$	0	incr.	infl.
1	$\frac{1}{2}$	0	$-$	max.	$\cap$
2	-4	-12	$-$	decr.	$\cap$



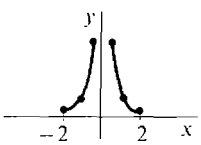
17

x	$f(x)$	$f'(x)$	$f''(x)$		
-4	$-\frac{1}{4}$	$-\frac{1}{16}$	$-$	decr.	$\cap$
-1	-1	-1	$-$	decr.	$\cap$
$-\frac{1}{4}$	-4	-16	$-$	decr.	$\cap$
$\frac{1}{4}$	4	-16	$+$	decr.	$\cup$
1	1	-1	$+$	decr.	$\cup$
4	$\frac{1}{4}$	$-\frac{1}{16}$	$+$	decr.	$\cup$



19

x	$f(x)$	$f'(x)$	$f''(x)$		
-2	$\frac{1}{4}$	$\frac{1}{4}$	$+$	incr.	$\cup$
-1	1	2	$+$	incr.	$\cup$
$-\frac{1}{2}$	4	16	$+$	incr.	$\cup$
$\frac{1}{2}$	4	-16	$+$	decr.	$\cup$
1	1	-2	$+$	decr.	$\cup$
2	$\frac{1}{4}$	$-\frac{1}{4}$	$+$	decr.	$\cup$

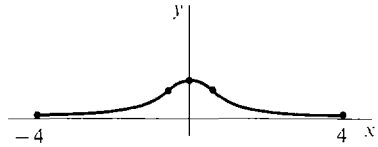


21

x	$f(x)$	$f'(x)$	$f''(x)$		
0	-1	2	$-$	incr.	$\cap$
1	0	$\frac{1}{2}$	$-$	incr.	$\cap$
10	$\frac{9}{11}$	$\frac{2}{121}$	$-$	incr.	$\cap$

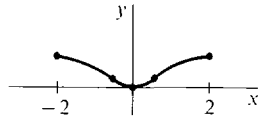
23

x	$f(x)$	$f'(x)$	$f''(x)$		
-4	$\frac{1}{17}$	.03	+	incr.	$\cup$
$-1/\sqrt{3}$	$\frac{3}{4}$	1.9	0	incr.	infl.
0	1	0	$-$	max.	$\cap$
$1/\sqrt{3}$	$\frac{3}{4}$	-1.9	0	decr.	infl.
4	$\frac{1}{17}$	$-.03$	+	decr.	$\cup$



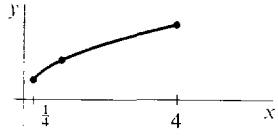
25

x	$f(x)$	$f'(x)$	$f''(x)$		
-2	$\frac{4}{5}$	$-\frac{2}{25}\sqrt{3}$	$-$	decr.	$\cap$
$-1/\sqrt{3}$	$\frac{1}{4}$	$-\sqrt{3}/2$	0	decr.	infl.
0	0	0	+	min.	$\cup$
$1/\sqrt{3}$	$\frac{1}{4}$	$\sqrt{3}/2$	0	incr.	infl.
2	$\frac{4}{5}$	$\frac{2}{25}\sqrt{3}$	$-$	incr.	$\cap$



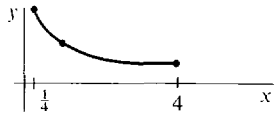
27

x	$f(x)$	$f'(x)$	$f''(x)$		
$\frac{1}{4}$	$\frac{1}{2}$	1	$-$	incr.	$\cap$
1	1	$\frac{1}{2}$	$-$	incr.	$\cap$
4	2	$\frac{1}{4}$	$-$	incr.	$\cap$



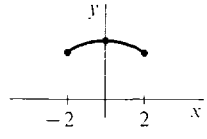
29

x	$f(x)$	$f'(x)$	$f''(x)$		
$\frac{1}{4}$	2	-4	+	decr.	$\cup$
1	1	$-\frac{1}{2}$	+	decr.	$\cup$
4	$\frac{1}{2}$	$-\frac{1}{16}$	+	decr.	$\cup$



31

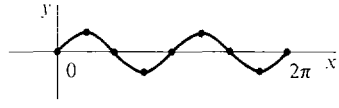
x	$f(x)$	$f'(x)$	$f''(x)$		
-2	$\sqrt{5}$	$2/\sqrt{5}$	$-$	incr.	$\cap$
0	3	0	$-$	max.	$\cap$
2	$\sqrt{5}$	$-2/\sqrt{5}$	$-$	decr.	$\cap$



33

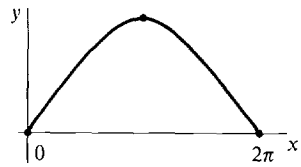
x	$f(x)$	$f'(x)$	$f''(x)$		
0	0	1	0	incr.	infl.
$\pi/4$	$\frac{1}{2}$	0	$-$	max.	$\cap$
$\pi/2$	0	-1	0	decr.	infl.
$3\pi/4$	$-\frac{1}{2}$	0	+	min.	$\cup$
π	0	1	0	incr.	infl.

repeats



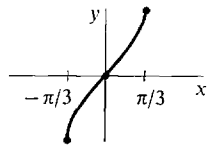
35

x	$f(x)$	$f'(x)$	$f''(x)$		
0	0	$\frac{3}{2}$	0	incr.	infl.
π	3	0	$-$	max.	$\cap$
2π	0	$-\frac{3}{2}$	0	decr.	infl.



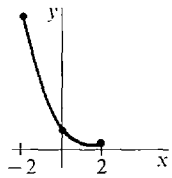
37

x	$f(x)$	$f'(x)$	$f''(x)$		
$-\pi/3$	$-\sqrt{3}$	4	$-$	incr.	$\cap$
0	0	1	0	incr.	infl.
$\pi/3$	$\sqrt{3}$	4	$+$	incr.	$\cup$



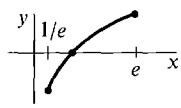
39

x	$f(x)$	$f'(x)$	$f''(x)$		
-2	e^2	$-e^2$	$+$	decr.	$\cup$
0	1	-1	$+$	decr.	$\cup$
2	e^{-2}	$-e^{-2}$	$+$	decr.	$\cup$



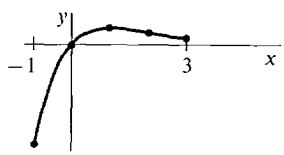
41

x	$f(x)$	$f'(x)$	$f''(x)$		
$1/e$	-1	e	$-$	incr.	$\cap$
1	0	1	$-$	incr.	$\cap$
e	1	$1/e$	$-$	incr.	$\cap$



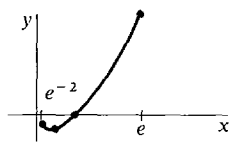
43

x	$f(x)$	$f'(x)$	$f''(x)$		
-1	$-e$	$2e$	$-$	incr.	$\cap$
0	0	1	$-$	incr.	$\cap$
1	e^{-1}	0	$-$	max.	$\cap$
2	$2e^{-2}$	$-e^{-2}$	0	decr.	infl.
3	$3e^{-3}$	$-2e^{-3}$	$+$	decr.	$\cup$



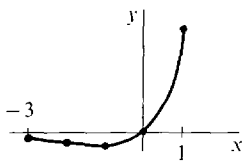
45

x	$f(x)$	$f'(x)$	$f''(x)$		
e^{-2}	$-2e^{-2}$	-1	e^2	decr.	$\cup$
e^{-1}	$-e^{-1}$	0	e	min.	$\cup$
1	0	1	1	incr.	$\cup$
e	e	2	e^{-1}	incr.	$\cup$



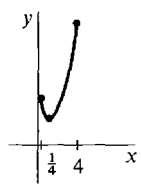
47

x	$f(x)$	$f'(x)$	$f''(x)$		
-3	$-3e^{-3}$	$-2e^{-3}$	$-$	decr.	$\cap$
-2	$-2e^{-2}$	$-e^{-2}$	0	decr.	infl.
-1	$-e^{-1}$	0	$+$	min.	$\cup$
0	0	1	$+$	incr.	$\cup$
1	e	$2e$	$+$	incr.	$\cup$



49

x	$f(x)$	$f'(x)$	$f''(x)$		
$\frac{1}{4}$	$4e^{\frac{1}{4}}$	$-12e^{\frac{1}{4}}$	$+$	decr.	$\cup$
1	e	0	$+$	min.	$\cup$
4	$e^4/4$	$\frac{3}{16}e^4$	$+$	incr.	$\cup$



Section 3.8

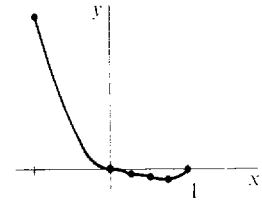
1 $f(0) = 1, f(1) = -1$ **3** $f(4) = 0.236, f(9) = -2.838$
5 $f(0) = 0.586, f(1) = -0.732$ **7** $f(0) = -1, f(1) = 1$ **9** $f(0) = 1, f(1) = -1$
11 $f(0) = -1, f(1) = 1$ **13** $f(0) = 0.9, f(\text{pi}) = -1.1$ **15** $f(1) = -1, f(e) = 0.632$
17 yes **19** yes **21** no **23** yes, $f'(16/7) = 0$ **25** no **27** yes **29** no
31 one **33** two **35** 1/2 **37** 8/27 **39** 1 **41** $\sqrt{3} - 1$
43 $f'(x) = 3x^2 - 3$ has no zeros in $(-1, 1)$

Extra Problems for Chapter 3

1 $A = 6V^{2/3}$ **3** $x = 300t$ **5** $s = 5x/4$ **7** $16/\pi$ in./sec **9** 0.01 in./sec
11 -3 **13** $-1/4$ **15** $-1 < x < 1$ **17** $-2 < x < -1, 1 < x < 2$ **19** none
21 max = 5 at $x = 1$, min = 3 at $x = 2$ **23** max = 4 at $x = 0$, min = 1 at $x = \pm 1$
25 square of side $\sqrt{2}$ **27** $8b^3/27a^3$ **29** min $= -32$ at $x = -2$, no max
31 base = height = 1 **33** three zeros

33

x	$f(x)$	$f'(x)$	$f''(x)$		
-1	2	-7	+	decr.	$\cup$
0	0	0	0	horiz.	infl.
$\frac{1}{4}$	$-\frac{3}{256}$	$-\frac{1}{8}$	$-$	decr.	$\cap$
$\frac{1}{2}$	$-\frac{1}{16}$	$-\frac{1}{4}$	0	decr.	infl.
$\frac{3}{4}$	$-\frac{27}{256}$	0	+	min.	$\cup$
1	0	1	+	incr.	$\cup$



37 none **39** $f(-1) = \sqrt[3]{7} - 2 < 0, f(0) = 1 > 0$

Section 4.1

1 2 **3** 5/4 **5** 11/8 **7** 11 **9** $-1/4$ **11** 136 **13** $901/280 = 3.2$
15 $177/512 = 0.35$ **17** $1 + \sqrt{2} + \sqrt{3}(\pi - 3) = 2.7$ **19** 1.90 **21** 1.55
23 3.18

Section 4.2

1 $(16/3)x^{3/2}$ **3** $t^3 + t$ **5** $4t - t^3$ **7** $-(7/2)s^{-2}$ **9** $(1/3)(x - 6)^3$
11 $(2/5)y^{5/2}$ **13** $x^2/2, x \geq 0; -x^2/2, x < 0$ **15** 2/3 **17** 12 **19** 0
21 32/3 **23** 14 **25** 12 **27** 9.9 **29** 16/3 **31** 1/6 **33** 2

Section 4.3

1 $x + x^2 + x^3 + C$ **3** $(3/2)t^8 - (1/2)t^6 + (2/3)t^3 + t + C$ **5** $(2/3)t^{3/2} + 2t^{1/2} + C$
7 $(1/6)(2x - 3)^3 + C$ **9** $(1/3)z^3 + 2z - z^{-1} + C$ **11** $5 \sin x + C$
13 $x + \ln x + C$ **15** $x + 2 \ln x - x^{-1} + C$ **17** $12t - (4/3)t^{3/2} - t^2 + C$
19 $-4y^{-1} - 6y^{-1/2} + 2\sqrt{y} + C$ **21** $(1/3)ax^3 + (1/2)bx^2 + cx + C$ **23** 0
25 58/15 **27** 0 **29** $3 \ln 2$ **31** $-\ln 3$ **33** $(4/3)t^3 - t + 2$
35 $-2 \cos t + 12$ **37** $v = (1/2)t^2, y = (1/6)t^3 + 1$
39 $v = t^3 + 1, y = (1/4)t^4 + t + 2$
41 $v = -(1/2)t^{-2} + 3/2, y = (1/2)t^{-1} + (3/2)t - 2$ **43** (*a*), (*d*), (*f*), (*g*), (*i*), (*l*)
45 $y = t^3 + 2t + 1$

Section 4.4

1 $-\dfrac{1}{2(2x + 1)} + C$ **3** $-\dfrac{1}{28}(3 - 4z)^7 + C$ **5** $-(2/3)(1 - t^2)^{3/2} + C$

7 $(1/30)(4 + 5x^2)^3 + C$ **9** $-(1/3)\cos(3x) + C$ **11** $-(3/2)\cos(4x - 1) + C$
13 $(1/2)\sin^2\theta + C$ **15** $-(1/4)\cos^4\theta + C$ **17** $-(1/2)\cos(x^2 + 1) + C$
19 $-\cos(\ln x) + C$ **21** $(2/3)(\sin t)^{3/2} + C$ **23** $(1/2)e^{2x} + C$
25 $ae^x - be^{-x} + C$ **27** $\frac{1}{2}e^{x^2} + C$ **29** $(b/a)e^{ax} + C$ **31** $e^{\sin\theta} + C$
33 $\ln(x + 2) + C$ **35** $\ln(e^x + 1) + C$ **37** $x - \ln(x + 1) + C$
39 $2\ln(1 + \sqrt{x}) + C$ **41** $-3t - 19\ln(5 - t) + C$ **43** $(1/6)(x^4 + 5)^{3/2} + C$
45 $(1/3)(2 + y^2)^{3/2} + C$ **47** $-(1 - u^2)^{1/2} + C$ **49** $(2/3)(3s + 2)^{1/2} + C$
51 $-2(1 + x^{-1})^{1/2} + C$ **53** $-(1/15)(3 + 5x^{-2})^{3/2} + C$ **55** $-(2/3)(3 - \sqrt{x})^3 + C$
57 $-2z^{-1} - (1/2)z^{-2} + C$ **59** $(2/3)(x^3 + 4)^{1/2} + C$ **61** $(1/2)(1 + x^4)^{1/2} + C$
63 $(2/5)(t + 1)^{5/2} - (2/3)(t + 1)^{3/2} + C$ **65** $(8/3)(1 - s)^{-3} - (1 - s)^{-2} + C$
67 $-(1/2)(y^2 + 1)^{-1} + (1/4)(y^2 + 1)^{-2} + C$
69 $(1/24)(4x + 1)^{3/2} - (1/8)(4x + 1)^{1/2} + C$ or $(1/12)(2x - 1)(4x + 1)^{1/2} + C$
71 $-(2/27)(1 - 3u)^{3/2} + (2/45)(1 - 3u)^{5/2} + C$ **73** $(1/6)(4x + 1)^{3/2} - (4x + 1)^{1/2} + C$
75 $-(1/4)\ln(1 - x^4) + C$ **77** $(1/4)y^4 - (1/2)y^2 + (1/2)\ln(1 + y^2) + C$ or
$(1/4)(1 + y^2)^2 - (1 + y^2) + (1/2)\ln(1 + y^2) + C$
79 $(2/3)\ln(3u + 2) + 3/(3u + 2) + C$ **81** $x - 4\sqrt{x} + 8\ln(2 + \sqrt{x}) + C$
83 $\ln(\sin\theta) + C$ **85** $(1/b)\ln(a + bx) + C$ **87** $-\ln(1 + \cos\theta) + C$
89 $(1/2)(\ln x)^2 + C$ **91** 1/2 **93** $e - e^{-1}$ **95** $\ln 2$ or $(1/2)\ln 4$ **97** 1/2
99 $(2/3)(3\sqrt{3} - 1)$ **101** 242/5 **103** 100 **105** $(1/6)(17\sqrt{17} - 27)$ **107** 0
109 $(\ln 7 - \ln 4)/3$ **111** 2/3 **113** 93/35 **115** 0 **117** $f(g(x)) + C$

Section 4.5

1 56/3 **3** 2 **5** $(10\sqrt{5}/3) - 6$ **7** 32/3 **9** 500/3 **11** 2 **13** 4
15 2 **17** $e^2 - 3$ **19** $2(e - e^{-1})$ **21** $2 - \ln 3$ **23** $(3/2) - \ln 2$ **25** 1/5
27 $128\sqrt{6}/5$ **29** 4/3 **31** 32/3 **33** 1/6 **35** 19/15 **37** 49/15
39 23/12 **41** 3/4 **43** $1 - (4/3)\cdot 2^{3/4} + (5/6)\cdot 2^{3/5} = 0.02$ **45** 11/4
47 $(3 + \sqrt{5})/2$ **49** $\sqrt[3]{54}$ or $3\sqrt[3]{2}$ **51** $c = (1/2)^{2/3}$ or $c = 2^{-2/3}$

Section 4.6

1 In all cases, sum = 2, error = 0.
3 (a) $\Delta x = 0.25$: sum = 1.0426 $\Delta x = 0.1$: sum = 1.0652
(b) $\Delta x = 0.25$: sum = 1.0594 $\Delta x = 0.1$: sum = 1.0700
In all cases, there is no error estimate.
5 (a) $\Delta x = 0.25$: sum = 0.3229, error $\leq 1/384$
$\Delta x = 0.1$: sum = 0.3220, error $\leq 1/2400$
(b) $\Delta x = 0.25$: sum = 0.3217108, error $\leq 1/15{,}360$
$\Delta x = 0.1$: sum = 0.3217505, error $\leq 1/600{,}000$
7 (a) $\Delta x = 0.5$: sum = 2.8968, error $\leq 1/48$
$\Delta x = 0.1$: sum = 2.9012, error $\leq 1/1200$
(b) $\Delta x = 0.5$: sum = 2.9013, error $\leq 1/960$
$\Delta x = 0.1$: sum = 2.901388, error $\leq 1/600{,}000$
9 (a) $\Delta x = 0.25$: sum = 1.0968, error $\leq \sqrt{2}/96$
$\Delta x = 0.1$: sum = 1.0906, error $\leq \sqrt{2}/600$
(b) $\Delta x = 0.25$: sum = 1.089413
$\Delta x = 0.1$: sum = 1.089430
11 (a) $\Delta x = 1$: sum = 2.0214, error ≤ 1
$\Delta x = 0.1$: sum = 1.9447, error ≤ 0.01
(b) $\Delta x = 1$: sum = 1.9587, error ≤ 0.8
$\Delta x = 0.1$: sum = 1.945913, error ≤ 0.0008
13 (a) $\Delta x = 3$: sum = 1.8793, error $\leq 45/8$
$\Delta x = 0.1$: sum = 1.6685, error $\leq 5/800$
(b) $\Delta x = 3$: sum = 1.738132
$\Delta x = 0.1$: sum = 1.668231

15 (a) $\Delta x = \pi/2$: sum = 1.5708, error $\leq \pi^3/48$ or 0.65
$\Delta x = \pi/10$: sum = 1.9835, error $\leq \pi^3/1200$ or 0.026
(b) $\Delta x = \pi/2$: sum = 2.0944, error $\leq \pi^5/2880$ or 0.1
$\Delta x = \pi/10$: sum = 2.00011, error $\leq \pi^5/1{,}800{,}000$ or 0.00017

17 (a) $\Delta x = 0.25$: sum = 1.7272 error $\leq e/192$ or 0.014
$\Delta x = 0.1$: sum = 1.7197, error $\leq e/1200$ or 0.002
(b) $\Delta x = 0.25$: sum = 1.718319, error $\leq e/46{,}080$ or 0.00006
$\Delta x = 0.1$: sum = 1.718283, error $\leq e/1{,}800{,}000$ or 0.0000015

19 (a) $\Delta x = 0.25$: sum = 0.3837, error $\leq 1/192$
$\Delta x = 0.1$: sum = 0.3859, error $\leq 1/1200$
(b) $\Delta x = 0.25$: sum = 0.386260, error $\leq 1/46{,}080$
$\Delta x = 0.1$: sum = 0.386293, error $\leq 1/1{,}800{,}000$

Extra Problems for Chapter 4

1 0.6025 **3** 7.875 **5** 1/3 **7** $76 + 40\sqrt{5}$ **9** $946\frac{2}{3}$ **11** 2
13 $2x + x^2/2 - x^3 + C$ **15** $-(1/4)(x^2 - 1)^{-2} + C$ **17** $-(1/3)(1 - 3u^2)^{1/2} + C$
19 $(1/3)[(2t + 1)^{3/2} - (2t - 1)^{3/2}] + C$ **21** $(2/5)u^{5/2} - (4/3)u^{3/2} + C$
23 $2 \sin(x/2) + C$ **25** $-e^{-t} + C$ **27** 40/3 **29** $(e^4 - 1)/4$ **31** $(x^3 + 2)^{1/2}$
33 $-\sqrt{u(u-1)^{1/2}}$ **35** $(1/2)x^2 - x + b + 1/2$ **37** $3x^2 - 6x + 5$
39 $F(x) = 1$ if $x < 0$, $(x^2/2) + 1$ if $x \geq 0$ **43** $\pi ab/2$ **45** $xf(x) + \int_0^x f(t)\,dt$

Section 5.1

1 3 **3** ∞ **5** 1/3 **7** 5/3 **9** $1/\sqrt{3}$ **11** ∞ **13** ∞ **15** 0
17 $-\infty$ **19** ∞ **21** 0 **23** 1/2 **25** $-1/4$ **27** 0 **29** $-5/6$ **31** 0
33 does not exist **35** ∞ **37** does not exist **39** does not exist **41** ∞
43 0 **45** $-\infty$ **47** 1/2 **49** ∞ **51** $-3/2$ **53** 0 **55** 1 **57** 0
59 does not exist **61** 0 **63** $-\infty$ **65** does not exist **67** ∞

Section 5.2

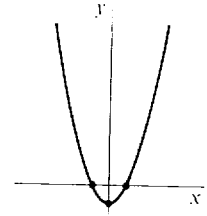
1 1/6 **3** 1/16 **5** 0 **7** $-1/4$ **9** 1/2 **11** -1 **13** 5 **15** ∞
17 2 **19** 3 **21** 1 **23** 2 **25** 1 **27** 1 **29** 1 **31** 1 **33** 1/2
35 0 **37** 1/2 **39** 1/2 **41** $4/\sqrt{2} = \sqrt{8}$ **43** 2 **45** ∞ **47** 3/2
49 5 **51** does not exist

Section 5.3

1 (a) A, B, F, H (b) B, F, H (c) B, F (d) A, B, C, D, F, G, H
(e) B, D, F, G, H (f) B, D, F

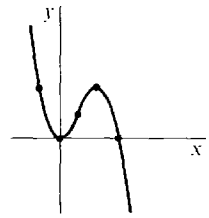
3

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x \to -\infty}$	∞	$-\infty$			
0	0	-2	+	decr.	$\cup$
1	-1	0	+	min.	$\cup$
2	0	2	+	incr.	$\cup$
$\lim_{x \to \infty}$	∞	∞			



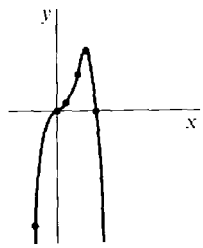
5

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	∞	$-\infty$			
-2	$5\frac{1}{3}$	-6	$+$	decr.	$\cup$
0	0	0	$+$	min.	$\cup$
2	$2\frac{2}{3}$	2	0	incr.	infl.
4	$5\frac{1}{3}$	0	$-$	max.	$\cap$
6	0	-6	$-$	decr.	$\cap$
$\lim_{x\to\infty}$	$-\infty$	$-\infty$			



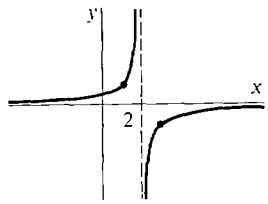
7

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	$-\infty$	∞			
-2	-12	20	$-$	incr.	$\cap$
0	0	0	0	horiz.	infl.
1	$\frac{3}{4}$	2	$+$	incr.	$\cup$
2	4	4	0	incr.	infl.
3	$6\frac{3}{4}$	0	$-$	max.	$\cap$
4	0	-16	$-$	decr.	$\cap$
$\lim_{x\to\infty}$	$-\infty$	$-\infty$			



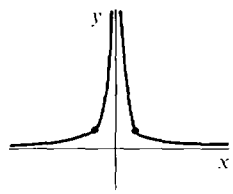
9

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	0	0			
1	1	1	$+$	incr.	$\cup$
$\lim_{x\to2^-}$	∞	∞			
$\lim_{x\to2^+}$	$-\infty$	∞			
3	-1	1	$-$	incr.	$\cap$
$\lim_{x\to\infty}$	0	0			



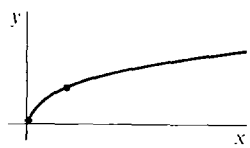
11

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	0	0			
-1	1	2	$+$	incr.	$\cup$
$\lim_{x\to0^-}$	∞	∞			
$\lim_{x\to0^+}$	∞	∞			
1	1	-2	$+$	decr.	$\cup$
$\lim_{x\to\infty}$	0	0			



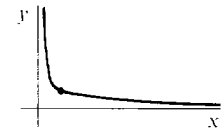
13

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to0^+}$	0	∞			
1	1	$\frac{1}{2}$	$-$	incr.	$\cap$
$\lim_{x\to\infty}$	∞	0			



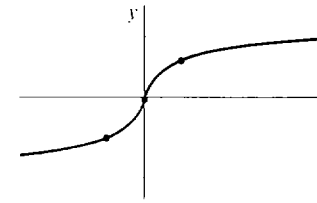
15

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to 0^+}$	∞	$-\infty$			
1	1	$-\frac{1}{2}$	+	decr.	$\cap$
$\lim_{x\to\infty}$	0	0			



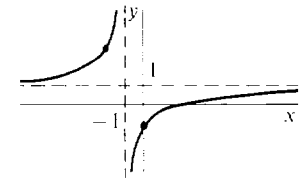
17

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	$-\infty$	0			
-1	-1	$\frac{1}{3}$	+	incr.	$\cup$
$\lim_{x\to 0^-}$	0	∞			
$\lim_{x\to 0^+}$	0	∞			
1	1	$\frac{1}{3}$	−	incr.	$\cap$
$\lim_{x\to\infty}$	∞	0			



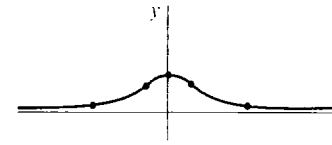
19

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	1	0			
-2	3	2	−	incr.	$\cap$
$\lim_{x\to-1^-}$	∞	∞			
$\lim_{x\to-1^+}$	$-\infty$	∞			
0	-1	2	−	incr.	$\cap$
$\lim_{x\to\infty}$	1	0			



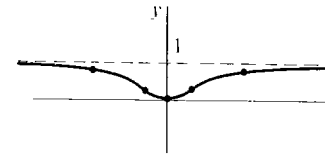
21

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	0	0			
-2	$\frac{1}{5}$	$\frac{4}{25}$	+	incr.	$\cup$
$-1/\sqrt{3}$	$\frac{3}{4}$	1.9	0	incr.	infl.
0	1	0	−	max.	$\cap$
$1/\sqrt{3}$	$\frac{3}{4}$	-1.9	0	decr.	infl.
2	$\frac{1}{5}$	$-\frac{4}{25}$	+	decr.	$\cup$
$\lim_{x\to\infty}$	0	0			



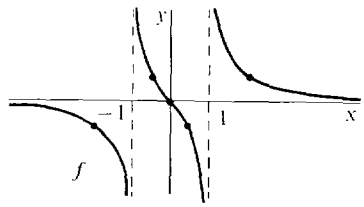
23

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	1	0			
-2	$\frac{4}{5}$	$-\frac{2}{25}$	−	decr.	$\cap$
$-1/\sqrt{3}$	$\frac{1}{4}$	$-\sqrt{3}/2$	0	decr.	infl.
0	0	0	+	min.	$\cup$
$1/\sqrt{3}$	$\frac{1}{4}$	$\sqrt{3}/2$	0	incr.	infl.
2	$\frac{4}{5}$	$\frac{2}{25}$	−	incr.	$\cap$
$\lim_{x\to\infty}$	1	0			



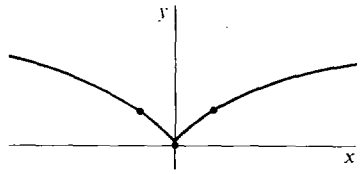
25

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	0	0			
-2	$-\frac{2}{3}$	$-\frac{5}{9}$	$-$	decr.	$\cap$
$\lim_{x\to-1^-}$	$-\infty$	$-\infty$			
$\lim_{x\to-1^+}$	∞	$-\infty$			
$-\frac{1}{2}$	$\frac{2}{3}$	$-\frac{20}{9}$	$+$	decr.	$\cup$
0	0	-1	0	decr.	infl.
$\frac{1}{2}$	$-\frac{2}{3}$	$-\frac{20}{9}$	$-$	decr.	$\cap$
$\lim_{x\to1^-}$	$-\infty$	$-\infty$			
$\lim_{x\to1^+}$	∞	$-\infty$			
2	$\frac{2}{3}$	$-\frac{5}{9}$	$+$	decr.	$\cup$
∞	0	0			



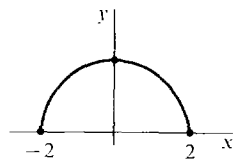
27

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	∞	0			
-1	1	$-\frac{2}{3}$	$-$	decr.	$\cap$
$\lim_{x\to0^-}$	0	$-\infty$		min. (cusp)	
$\lim_{x\to0^+}$	0	∞			
1	1	$\frac{2}{3}$	$-$	incr.	$\cap$
$\lim_{x\to\infty}$	∞	0			



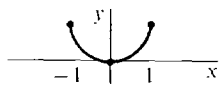
29

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-2^+}$	0	∞			
0	2	0	$-$	max.	$\cap$
$\lim_{x\to2^-}$	0	$-\infty$			



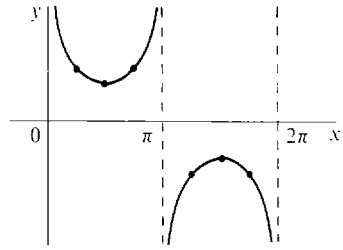
31

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-1^+}$	1	$-\infty$			
0	0	0	$+$	min.	$\cup$
$\lim_{x\to1^-}$	1	∞			



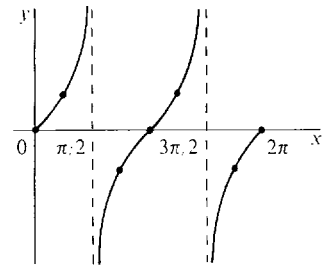
33

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to 0^+}$	∞	$-\infty$			
$\pi/4$	$\sqrt{2}$	$-\sqrt{2}$	$+$	decr.	$\cup$
$\pi/2$	1	0	$+$	min.	$\cup$
$3\pi/4$	$\sqrt{2}$	$\sqrt{2}$	$+$	incr.	$\cup$
$\lim_{x\to \pi^-}$	∞	∞			
$\lim_{x\to \pi^+}$	$-\infty$	∞			
$5\pi/4$	$-\sqrt{2}$	$\sqrt{2}$	$-$	incr.	$\cap$
$3\pi/2$	-1	0	$-$	max.	$\cap$
$7\pi/4$	$-\sqrt{2}$	$-\sqrt{2}$	$-$	decr.	$\cap$
$\lim_{x\to 2\pi^-}$	$-\infty$	$-\infty$			



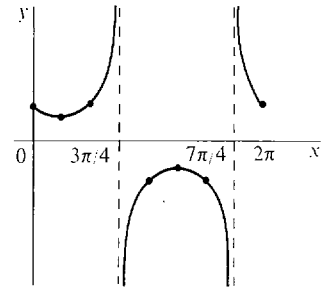
35

x	$f(x)$	$f'(x)$	$f''(x)$		
0	0	1	0	incr.	infl.
$\pi/4$	1	2	$+$	incr.	$\cup$
$\lim_{x\to \pi/2^-}$	∞	∞			
$\lim_{x\to \pi/2^+}$	$-\infty$	∞			
$3\pi/4$	-1	2	$-$	incr.	$\cap$
π	0	1	0	incr.	infl.
$5\pi/4$	1	2	$+$	incr.	$\cup$
$\lim_{x\to 3\pi/2^-}$	∞	∞			
$\lim_{x\to 3\pi/2^+}$	$-\infty$	∞			
$7\pi/4$	-1	2	$-$	incr.	$\cap$
2π	0	1	0	incr.	infl.



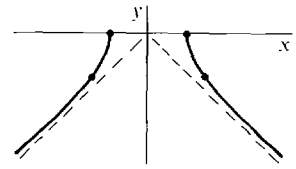
37

x	$f(x)$	$f'(x)$	$f''(x)$		
0	1	-1	$+$	decr.	$\cup$
$\pi/4$	$\sqrt{2}/2$	0	$+$	min.	$\cup$
$\pi/2$	1	1	$+$	incr.	$\cup$
$\lim_{x\to 3\pi/4^-}$	∞	∞			
$\lim_{x\to 3\pi/4^+}$	$-\infty$	∞			
π	-1	1	$-$	incr.	$\cap$
$5\pi/4$	$-\sqrt{2}/2$	0	$-$	max.	$\cap$
$3\pi/2$	-1	-1	$-$	decr.	$\cap$
$\lim_{x\to 7\pi/4^-}$	$-\infty$	$-\infty$			
$\lim_{x\to 7\pi/4^+}$	∞	$-\infty$			
2π	1	-1	$+$	decr.	$\cup$



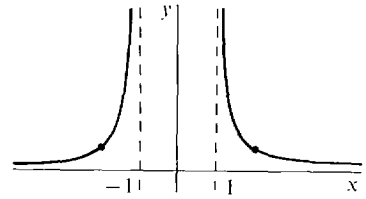
39

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	$-\infty$	1			
-3	$-\sqrt{5}$	$3/\sqrt{5}$	+	incr.	$\cup$
$\lim_{x\to-2^-}$	0	∞			
$\lim_{x\to2^+}$	0	$-\infty$			
3	$-\sqrt{5}$	$-3/\sqrt{5}$	+	decr.	$\cup$
$\lim_{x\to\infty}$	$-\infty$	-1			



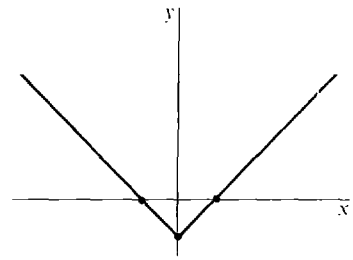
41

x	$f(x)$	$f(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	0	0			
-2	$1/\sqrt{3}$	$2/(3\sqrt{3})$	+	incr.	$\cup$
$\lim_{x\to-1^-}$	∞	∞			
$\lim_{x\to1^+}$	∞	$-\infty$			
2	$1/\sqrt{3}$	$-2/(3\sqrt{3})$	+	decr.	$\cup$
$\lim_{x\to\infty}$	0	0			



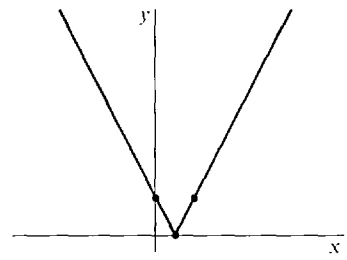
43

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	∞	-1			
-1	0	-1	0	decr.	linear
$\lim_{x\to0^-}$	-1	-1		min. (corner)	
$\lim_{x\to0^+}$	-1	1			
1	0	1	0	incr.	linear
$\lim_{x\to\infty}$	∞	1			



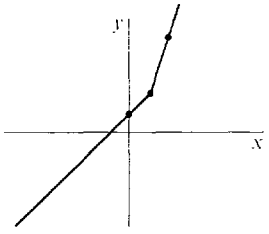
45

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	∞	-2			
0	1	-2	0	decr.	linear
$\lim_{x\to\frac{1}{2}^-}$	0	-2		min. (corner)	
$\lim_{x\to\frac{1}{2}^+}$	0	2			
1	1	2	0	incr.	linear
$\lim_{x\to\infty}$	∞	2			



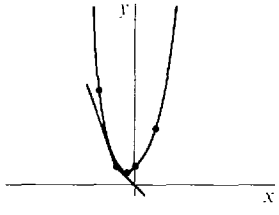
47

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	$-\infty$	1			
0	2	1	0	incr.	linear
$\lim_{x\to 2^-}$	4	1		corner	
$\lim_{x\to 2^+}$	4	3			
4	10	3	0	incr.	linear
$\lim_{x\to\infty}$	∞	3			



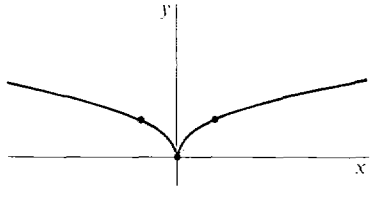
49

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	∞	$-\infty$			
-2	5	-5	2	decr.	$\cup$
$\lim_{x\to-1^-}$	1	-3		corner	
$\lim_{x\to-1^+}$	1	-1			
$-\frac{1}{2}$	$\frac{3}{4}$	0	2	min.	$\cup$
0	1	1	2	incr.	$\cup$
1	3	3	2	incr.	$\cup$
$\lim_{x\to\infty}$	∞	∞			



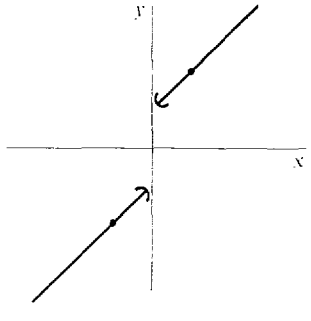
51

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	∞	0			
-1	1	$-\frac{1}{2}$	$-$	decr.	$\cap$
$\lim_{x\to0^-}$	0	$-\infty$		min. (cusp)	
$\lim_{x\to0^+}$	0	∞			
1	1	$\frac{1}{2}$	$-$	incr.	$\cap$
$\lim_{x\to\infty}$	∞	0			



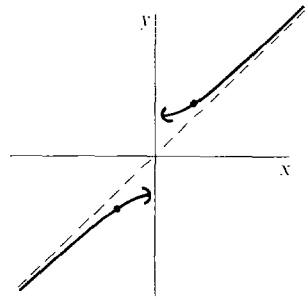
53

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	$-\infty$	1			
-1	-2	1	0	incr.	linear
$\lim_{x\to0^-}$	-1	1		jump	
$\lim_{x\to0^+}$	1	1			
1	2	1	0	incr.	linear
$\lim_{x\to\infty}$	∞	1			



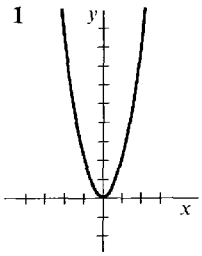
55

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	$-\infty$	1			
-1	$-\sqrt{2}$	$1/\sqrt{2}$	$-$	incr.	$\cap$
$\lim_{x\to0^-}$	-1	0		jump	
$\lim_{x\to0^+}$	1	0			
1	$\sqrt{2}$	$1/\sqrt{2}$	$+$	incr.	$\cup$
$\lim_{x\to\infty}$	∞	1			

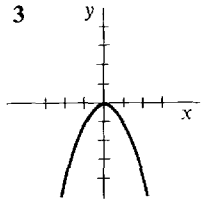


Section 5.4

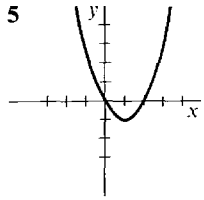
1



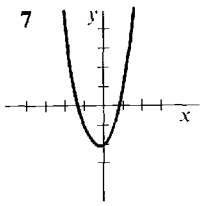
3



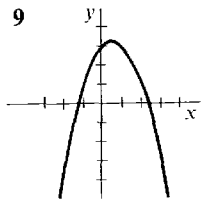
5



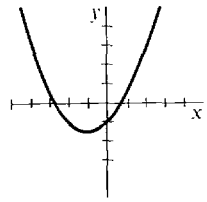
7



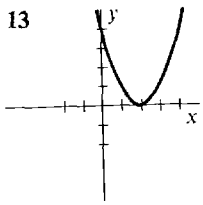
9



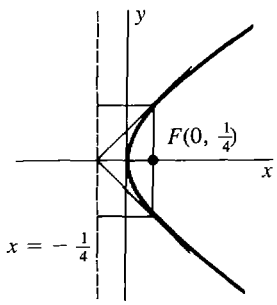
11



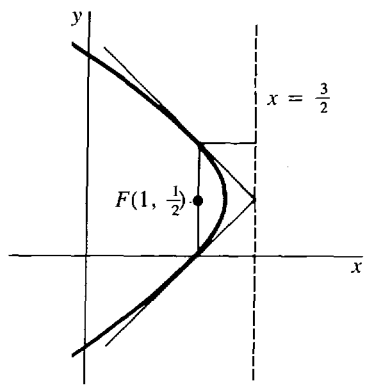
13



15 focus (1/4, 0), directrix $x = -1/4$



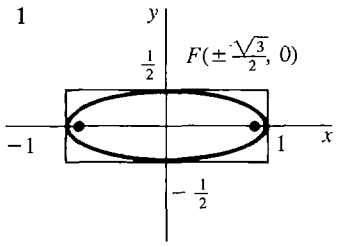
17 focus (3/2, 1/2), directrix $x = 2$



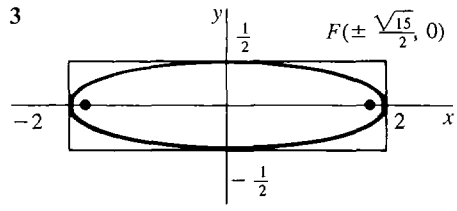
19 $y = (1/4)x^2 - x + 2$ **21** (1,3)

Section 5.5

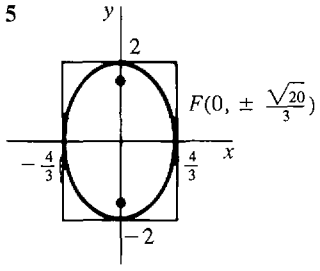
1



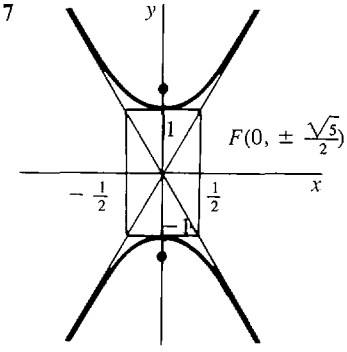
3



5



7



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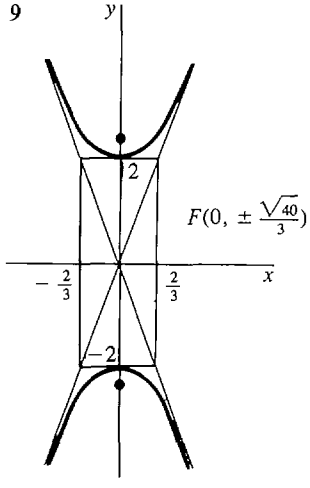

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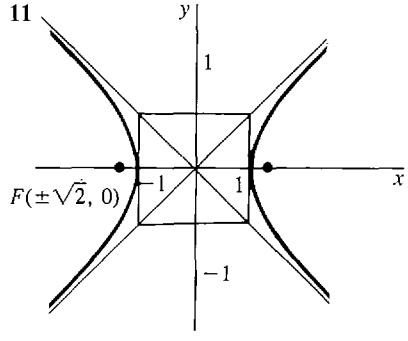
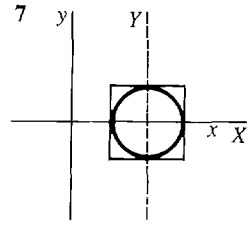
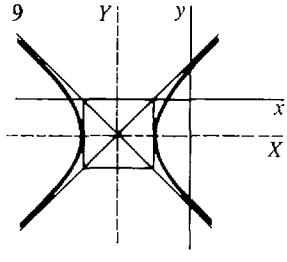


Section 5.6

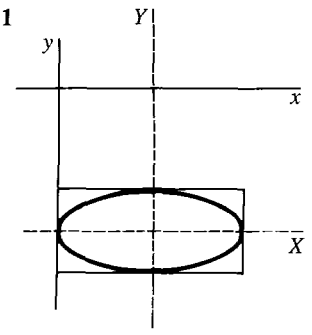
1 hyperbola 3 parabola 5 ellipse 7



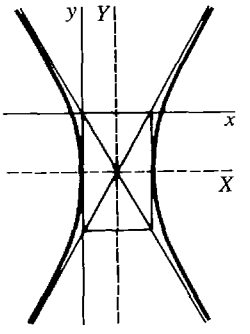
9



11



13



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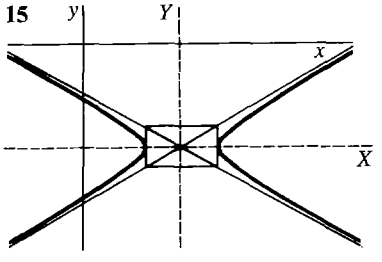

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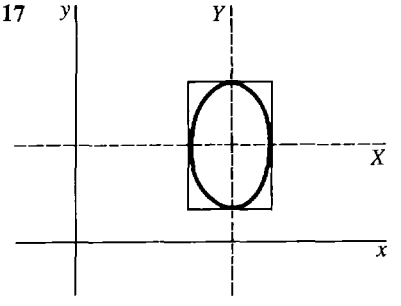


Section 5.7

1 $\alpha = 45°, X^2 - Y^2 + 8 = 0$ **3** $\alpha = 45°, -2X^2 + 6Y^2 = 1$
5 $\alpha = 30°, 2X^2 - 2Y^2 = 7$ **7** $\alpha = 22.5°, 1.207X^2 - 0.207Y^2 = 3$
9 $\alpha = -15°, 4.232X^2 + 0.768Y^2 = 5$

Section 5.8

Any smaller value of $\delta > 0$ or larger value of B is also correct.

1 $\delta = 10^{-3}$ **3** $\delta = 2 - (0.51)^{-1} \sim 0.039$ **5** $\delta = 10^{-4}$
7 $\delta = 1 - \sqrt{1 - 10^{-6}} \sim 5 \times 10^{-7}$ **9** $\delta = 10^{-2}$ **11** $\delta = 10^{-3}$ **13** $\delta = 10^{-4}$
15 $\delta = 1 - \sqrt{0.99} \sim 5 \times 10^{-3}$ **17** $B = 99/4 = 24.75$ **19** $B = \dfrac{5 + \sqrt{8025}}{4} \sim 23.7$
21 $B = \dfrac{10^4 - 1}{5} \sim 2 \times 10^3$
23 For all $\varepsilon > 0$ there exists $\delta > 0$ such that whenever $c - \delta < x < c$, $|f(x) - L| < \varepsilon$.
25 For all $A > 0$ there exists $B > 0$ such that whenever $x > B$, $f(x) < -A$.

Section 5.9

1 1.42332 **3** 0.63688 **5** 1.22074 **7** 2.93923 **9** 0.38197 **11** 0.56714
13 1.10606 **15** 1.30633

Section 5.10

1 $f'(1) = 2$, error $\leq \Delta x$ **3** $f'(4) = -(1/8)$, error $\leq (3/128)\,\Delta x$
5 $f'(3) = -1/9$, error $\leq (1/27)\,\Delta x$ **7** $f'(0) = 1$, error $\leq 0.5\,\Delta x$
9 $f'(\pi/3) = -\sqrt{3}$, error $\leq 2\,\Delta x$ **11** $f'(1) = 1$, error $\leq \Delta x/2$

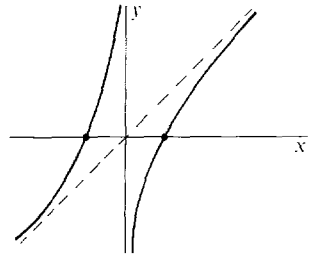
13 $f'(1) = e$, error $\le (1/2)e\,\Delta x$
15 $f'(100) = 1/20$, error $\le (1/8)\cdot 99^{-3/2}\,\Delta x$ or $0.000127\,\Delta x$
17 $f'(2) = (2/\sqrt{5})$, error $\le 1/(4\sqrt{2})\,\Delta x$ **19** $f'(1) = \sqrt{2} + 2^{-3/2}$, error $\le \Delta x/2$
21 $\sqrt{65} \sim 8\frac{1}{16}$, error $\le 1/4096$ **23** $(0.301)^4$ or 0.008208, error $\le 6 \times 10^{-7}$
25 $1/97$ or $10^{-2} + 3 \times 10^{-4} = 0.0103$, error $\le 10^{-5}$
27 $\sqrt{1.02} + \sqrt[3]{1.02} \sim 2\frac{1}{60}$, error $\le \frac{17}{18} \times 10^{-4}$ **29** $(1.003)^5$ or 1.015, error $\le 10^{-4}$
31 $\sin(\pi/3 + 0.004)$ or $\sqrt{3}/2 + 0.002$, error $\le 8 \times 10^{-6}$
33 $\tan(0.005)$ or 0.005, error $\le 10^{-6}$ **35** $e^{0.002}$ or 1.002, error $\le 3 \times 10^{-6}$
37 $\ln(1.006)$ or 0.006, error $\le 18 \times 10^{-6}$

Extra Problems for Chapter 5

1 0 **3** 0 **5** ∞ **7** 0 **9** 3/2

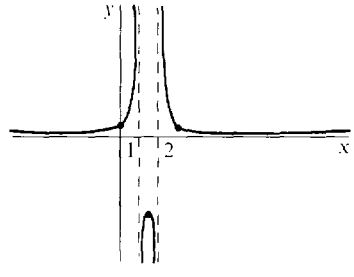
11

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	$-\infty$	1			
-1	0	2	+	incr.	$\cup$
$\lim_{x\to 0^-}$	∞	∞			
$\lim_{x\to 0^+}$	$-\infty$	∞			
1	0	2	−	incr.	$\cap$
$\lim_{x\to\infty}$	∞	1			



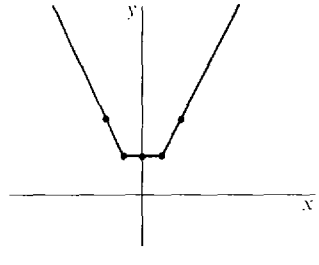
13

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	0	0			
0	$\frac{1}{2}$	$\frac{3}{4}$	+	incr.	$\cup$
$\lim_{x\to 1^-}$	∞	∞			
$\lim_{x\to 1^+}$	$-\infty$	∞			
$\frac{3}{2}$	-4	0	−	max.	$\cap$
$\lim_{x\to 2^-}$	$-\infty$	$-\infty$			
$\lim_{x\to 2^+}$	∞	$-\infty$			
3	$\frac{1}{2}$	$-\frac{3}{4}$	+	decr.	$\cup$
$\lim_{x\to\infty}$	0	0			



15

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	∞	-2			
-2	4	-2	0	decr.	linear
$\lim_{x\to-1^-}$	2	-2		corner	
$\lim_{x\to-1^+}$	2	0			
0	2	0	0	constant	linear
$\lim_{x\to 1^-}$	2	0		corner	
$\lim_{x\to 1^+}$	2	2			
2	4	2	0	incr.	linear
$\lim_{x\to\infty}$	∞	2			



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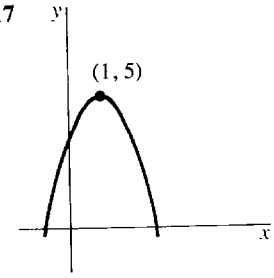

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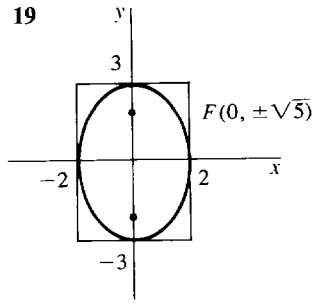

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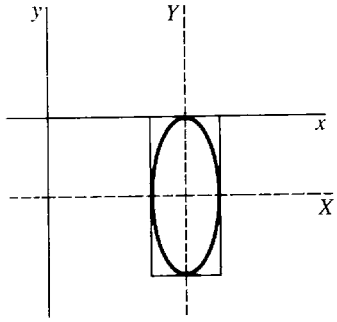


23 $\alpha = 45°$, $X^2 - Y^2 = 18$ **25** $\delta \le 0.155$ **27** 1.7866 **29** $(3/4096)\,\Delta x$
31 $25 - 2/15 = 24.8666$, error $\le 1/(9 \cdot (124)^{4/3})$

Section 6.1

1 $1/3$ **3** $\sqrt{3}/12$ **5** $\pi/24$ **7** $2cr^2/3$

Section 6.2

1 (a) $\pi/5$ (b) $\pi/2$ **3** (a) 8π (b) $128\pi/5$ **5** (a) $\pi/3$ (b) $\pi/3$
7 (a) $4\pi/3$ (b) $(2/3)\pi(2\sqrt{2} - 1)$ **9** (a) $31\pi/160$ (b) π **11** (a) $4\pi/45$ (b) $\pi/3$
13 (a) 27π (b) 18π **15** (a) $2\pi/35$ (b) $\pi/10$ **17** (a) $\pi/3$ (b) $\pi/9$
19 $20\pi/3$ (b) $29\pi/6$ **21** (a) $16\pi/3$ (b) $184\pi/15$ **23** 2π **25** $(\pi^2/4) - (\pi/2)$
27 $(\pi/2)(e^2 - 1)$ **29** $(\pi/6)(e^2 - 1)$ **31** $\pi \ln 2$ **33** $\pi(3 - \ln 4)$ **35** 2π
37 2π **39** $\pi(e - 1)$ **41** $2\pi(e^{-1} - e^{-4})$ **43** $2\pi \ln 2$ **45** $(\pi/2)\ln 7$

47 $\frac{4}{3}\pi(r^2 - a^2)^{3/2}$ **49** $\dfrac{1}{3}\pi r^2 h - \pi a^2 h + \dfrac{2\pi h a^3}{3r}$

51 (a) $\pi\left(\dfrac{b^2 a}{3} + \dfrac{2}{3}r^3 - r^2 a + \dfrac{a^3}{3}\right)$ or $\dfrac{2}{3}\pi r^2(r - a)$

(b) $\frac{2}{3}\pi(ba^2 + b^3)$ or $\frac{2}{3}\pi[a^2\sqrt{r^2 - a^2} + (r^2 - a^2)^{3/2}]$ **53** $2\pi^2 cr^2$

Section 6.3

1 $\frac{2}{3}(6\sqrt{6} - 3\sqrt{3})$ **3** $\frac{8}{3}((3\sqrt{3}/2\sqrt{2}) - 1)$ **5** $\frac{8}{27}(10\sqrt{10} - 1)$ **7** $379/12$

9 $387/20$ **11** $3/2$ **13** 36 **15** $\frac{4}{5}(2^{5/2} - 1)$ **17** $2\sqrt{3}/3$

19 $8 \cdot 10\sqrt{10} - 37\sqrt{37}$ **21** 2π **23** $4\sqrt{2}$ **25** $\dfrac{t^2}{\sqrt{1 + 4t^2}}$

27 $\displaystyle\int_0^4 \sqrt{1 + (4x - 1)^2}\,dx$ **29** $\displaystyle\int_1^2 \sqrt{4 + \frac{1}{4t}}\,dt$

31 $\displaystyle\int_1^2 \sqrt{1+\frac{1}{4x}}\,dx \sim \frac{1}{4}\left(\frac{\sqrt{5}}{4}+\sqrt{\frac{3}{2}}+\sqrt{\frac{7}{4}}+\sqrt{2}+\frac{3}{4}\right) \sim 1.32$

33 $\displaystyle\int_1^5 \sqrt{1+x^{-4}}\,dx \sim \frac{\sqrt{2}}{2}+\frac{\sqrt{17}}{4}+\frac{\sqrt{82}}{9}+\frac{\sqrt{257}}{16}+\frac{\sqrt{626}}{50} \sim 4.246$

Section 6.4

1 $\frac{\pi}{6}(17\sqrt{17}-1)$ **3** $\frac{2\pi}{81}\left(\frac{2}{5}\cdot 10^{5/2}-\frac{2}{3}\cdot 10^{3/2}+\frac{4}{15}\right) \sim 8.2$ **5** $256\pi/15$

7 $1575\pi/8$ **9** $\frac{2\pi}{3}(10\sqrt{10}-2\sqrt{2})$ **11** $\pi(2\sqrt{2}-1)$ **13** $\frac{\pi}{9}(2\sqrt{2}-1)$

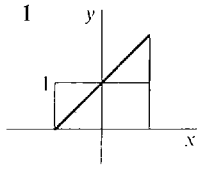
15 $47\pi/16$ **17** $7\pi/9$ **19** $16\pi\sqrt{5}$ **21** $2\pi ra$ **23** (a) $\displaystyle\int_0^1 2\pi x\sqrt{1+25x^8}\,dx$

(b) $\displaystyle\int_0^1 2\pi x^5\sqrt{1+25x^8}\,dx$ **25** (a) $\displaystyle\int_1^{10} 2\pi(t^2+t)\sqrt{8t^2+4t+1}\,dt$

(b) $\displaystyle\int_1^{10} 2\pi(t^2-1)\sqrt{8t^2+4t+1}\,dt$ **27** $\displaystyle\int_0^1 \pi x^2\sqrt{1+x^2}\,dx \sim 1.357$

Section 6.5

1



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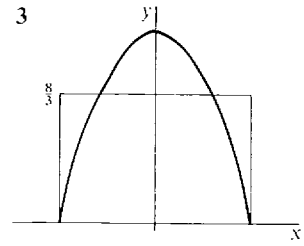

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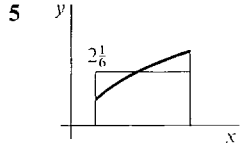

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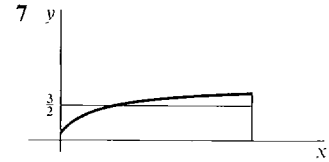


9 $3-(2/\sqrt{3})$ **11** -6 **13** 0 **15** $2/\pi$ **17** $1/\pi$ **19** $(1/2)(e-e^{-1})$
21 $(1/3)\ln 4$ **23** 1 **25** 8/9 **27** $6\sqrt{15}/25$ **29** 13/2 **31** 116/45
33 (a) 2 (b) 32/7

Section 6.6

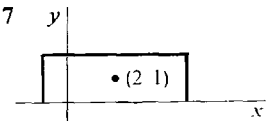
1 (a) 4 (b) $M_x = 0, M_y = 4$ (c) $(1,0)$ **3** (a) 128/3 (b) $M_x = 512/5, M_y = 0$
(c) $(0, 12/5)$ **5** (a) $6k$ (b) $M_x = 8k, M_y = 2k$ (c) $(\frac{1}{3}, \frac{4}{3})$ **7** (a) 128/15
(b) $M_x = 1024/105, M_y = 0$ (c) $(0, \frac{8}{7})$ **9** (a) $\frac{1}{2}$ (b) $M_x = \frac{1}{8}, M_y = \frac{1}{3}$ (c) $(\frac{2}{3}, \frac{1}{4})$

11 (a) $2\sqrt{2}-2$ (b) $M_x = 1-\dfrac{\sqrt{2}}{2}, M_y = \dfrac{4\sqrt{2}-2}{3}$

(c) $\left(\dfrac{2\sqrt{2}-1}{3\sqrt{2}-3}, \dfrac{2-\sqrt{2}}{4\sqrt{2}-4}\right)$ or $\left(1+\dfrac{\sqrt{2}}{3}, \dfrac{\sqrt{2}}{4}\right)$

13 (a) 4/3 (b) $M_x = 1/2, M_y = 0$ (c) $(0, 3/8)$
15 (a) 128/3 (b) $M_x = 1024/15, M_y = 512/5$ (c) $(\frac{12}{5}, \frac{8}{5})$

17



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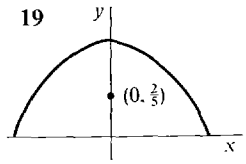

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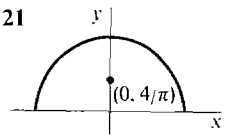

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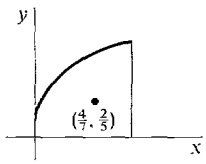


25 2/3 **27** $e^2 - 1$ **29** (2 ln 2, 7/24) **31** (8/15, 16/105) **33** (1/2, 2/5)
35 80 ft lbs **37** 320/3 ft lbs **39** 50 ft lbs **41** 215 ft lbs **43** $9k/400$

Section 6.7

1 1/2 **3** diverges to ∞ **5** diverges to $-\infty$ **7** diverges to ∞ **9** 1/2
11 diverges to ∞ **13** 3 **15** 6 **17** $-3/2$ **19** 3 **21** diverges to ∞
23 diverges to ∞ **25** diverges **27** 1/2 **29** diverges **31** $4\sqrt{2}$ **33** ∞
37 4 **39** 2/3 **43** (a) π (b) ∞ **45** (a) ∞ (b) 8π **47** 4/3
49 (a) $11\pi/9$ (b) $16\pi/15$ **51** (a) $\frac{\pi}{6}(5\sqrt{5} - 1)$ (b) $\int_0^1 2\pi x\sqrt{1 + \frac{1}{4x}}\,dx$
53 (a) $2\pi ra$ (b) $2\pi r^2 - 2\pi r\sqrt{r^2 - a^2}$

Extra Problems for Chapter 6

1 $8r^3/3$ **3** $2r^3/3$ **5** (a) $11\pi/3$ (b) $(16\pi/3) - 2\pi\sqrt{3}$ **7** (a) 16π (b) $16\pi/3$
9 $\pi p/(p + 1)$ **11** $\frac{1}{27}(46\sqrt{46} - 10\sqrt{10})$ **13** 5 **15** $(b - a)\sqrt{A^2 + C^2}$
17 $\frac{\pi}{3A}[(8A^2 + 4AB + B^2)^{3/2} - (4A^2 + B^2)^{3/2}]$ **19** $\frac{b^{p+1} - 1}{(b - 1)(p + 1)}$ **21** $(p + 1)^{-1/p}$
23 $(\frac{1}{2}, \frac{2}{3})$ **25** $(\frac{5}{7}, 0)$ **27** 15 ft lbs **29** diverges to ∞ **31** $-5/4$
33 diverges to ∞ **35** 8 **37** $a^2h/3$ **39** $m = \pi\rho$, $M_x = 2\rho$, $M_y = 0$, $(\bar{x}, \bar{y}) = (0, 2/\pi)$
43 $\pi\rho r^4/4$ **45** $w\rho b^2/2$

Section 7.1

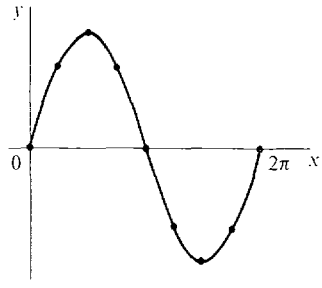
7 $(\pi/4) + k\pi$ **9** none **13** 0 **15** 0 **17** 0 **19** $k\pi$

Section 7.2

1 $5\cos(5x)$ **3** $6\theta\cos(3\theta^2)$ **5** $4\sec^2(4\theta - 3)$ **7** $a\cos\theta - b\sin\theta$
9 $-\frac{1}{2\sqrt{x}}\sin(\sqrt{x})$ **11** $\cos\theta\sec^2(\sin\theta)$ **13** $\frac{3\csc(3t)\cot(3t)}{(2 + \csc(3t))^2}$ **15** $\frac{1}{2\sin y\cos y}$
17 3/2 **19** ∞ **21** 2 **23** 1

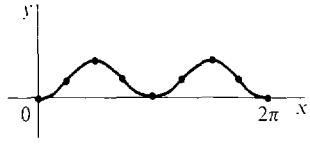
25

x	$f(x)$	$f'(x)$	$f''(x)$		
0	0	3	0	incr.	infl.
$\pi/4$	$3/\sqrt{2}$	$3/\sqrt{2}$	$-$	incr.	$\cap$
$\pi/2$	3	0	$-$	max.	$\cap$
$3\pi/4$	$3/\sqrt{2}$	$-3/\sqrt{2}$	$-$	decr.	$\cap$
π	0	-3	0	decr.	infl.
$5\pi/4$	$-3/\sqrt{2}$	$-3/\sqrt{2}$	$+$	decr.	$\cup$
$3\pi/2$	-3	0	$+$	min.	$\cup$
$7\pi/4$	$-3/\sqrt{2}$	$3/\sqrt{2}$	$+$	incr.	$\cup$
2π	0	3	0	incr.	infl.



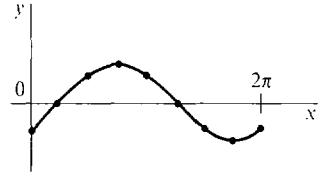
27

x	$f(x)$	$f'(x)$	$f''(x)$		
0	0	0	$+$	min.	$\cup$
$\pi/4$	1/2	1	0	incr.	infl.
$\pi/2$	1	0	$-$	max.	$\cap$
$3\pi/4$	1/2	-1	0	decr.	infl.
π	0	0	$+$	min.	$\cup$
$5\pi/4$	1/2	1	0	incr.	infl.
$3\pi/2$	1	0	$-$	max.	$\cap$
$7\pi/4$	1/2	-1	0	decr.	infl.
2π	0	0	$+$	min.	$\cup$



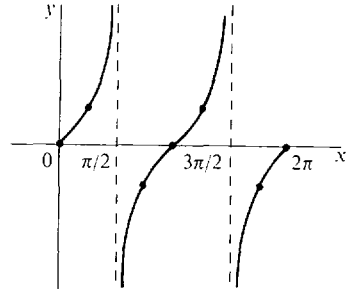
29

x	$f(x)$	$f'(x)$	$f''(x)$		
0	$-1/\sqrt{2}$	$1/\sqrt{2}$	$+$	incr.	$\cup$
$\pi/4$	0	1	0	incr.	infl.
$\pi/2$	$1/\sqrt{2}$	$1/\sqrt{2}$	$-$	incr.	$\cap$
$3\pi/4$	1	0	$-$	max.	$\cap$
π	$1/\sqrt{2}$	$-1/\sqrt{2}$	$-$	decr.	$\cap$
$5\pi/4$	0	-1	0	decr.	infl.
$3\pi/2$	$-1/\sqrt{2}$	$-1/\sqrt{2}$	$+$	decr.	$\cup$
$7\pi/4$	-1	0	$+$	min.	$\cup$
2π	$-1/\sqrt{2}$	$1/\sqrt{2}$	$+$	incr.	$\cup$



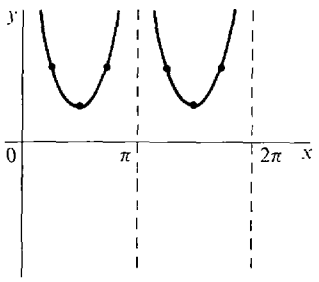
31

x	$f(x)$	$f'(x)$	$f''(x)$		
0	0	1	0	incr.	infl.
$\pi/4$	1	2	$+$	incr.	$\cup$
$\lim_{x\to\pi/2^-}$	∞	∞			
$\lim_{x\to\pi/2^+}$	$-\infty$	∞			
$3\pi/4$	-1	2	$-$	incr.	$\cap$
π	0	1	0	incr.	infl.
$5\pi/4$	1	2	$+$	incr.	$\cup$
$\lim_{x\to 3\pi/2^-}$	∞	∞			
$\lim_{x\to 3\pi/2^+}$	$-\infty$	∞			
$7\pi/4$	-1	2	$-$	incr.	$\cap$
2π	0	1	0	incr.	infl.



33

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to 0^+}$	∞	$-\infty$			
$\pi/4$	2	-4	+	decr.	$\cup$
$\pi/2$	1	0	+	min.	$\cup$
$3\pi/4$	2	4	+	incr.	$\cup$
$\lim_{x\to\pi^-}$	∞	∞			
$\lim_{x\to\pi^+}$	∞	$-\infty$			
$5\pi/4$	2	-4	+	decr.	$\cup$
$3\pi/2$	1	0	+	min.	$\cup$
$7\pi/4$	2	4	+	incr.	$\cup$
$\lim_{x\to 2\pi^-}$	∞	∞			



37 $-\frac{1}{2}\cos(2t) + C$ **39** $\frac{1}{3}\sec^3 x + C$ **41** $2\sin(\sqrt{x}) + C$ **43** $-\frac{1}{5}\csc(5\theta) + C$
45 $2\sqrt{\sec x + 1} + C$ **47** $\tan\theta - \sec\theta + C$ **49** 2 **51** $(3 - \sqrt{3})/2$ **53** ∞
55 $-\frac{3}{10}$ radians/sec **57** 6 **59** 1/2 **61** 2π **63** $\sqrt{2}$ **65** $\pi\sqrt{2}$

Section 7.3

1 $\pi/3$ **3** $-\pi/4$ **5** $\pi/3$ **7** $\sqrt{1-x^2}$ **9** $\frac{\pi}{2} - x$

15 $\dfrac{5}{|5x-2|\sqrt{(5x-2)^2-1}}$ **17** $\dfrac{2x}{\sqrt{1-x^4}}$ **19** $\arcsin t + \dfrac{t}{\sqrt{1-t^2}}$ **21** $\dfrac{1-x}{\sqrt{1-x^2}}$

23 $\arcsin x$ **25** $-\dfrac{1}{2\sqrt{x}(x+1)}$ **27** $-\pi/2$ **29** 1 **31** $\frac{1}{3}\arctan(x/3) + C$
33 $\arcsin(2x-1) + C$ **35** $\operatorname{arcsec}(2x) + C$ **37** $\frac{1}{2}\arcsin(x^2) + C$
39 $2\operatorname{arcsec}(\sqrt{x}) + C$ or $2\arctan(\sqrt{x-1}) + C$ **41** $\frac{1}{2}(\arcsin x)^2 + C$ **43** $\pi/3$
45 $\pi/6$ **47** π/a **49** $\pi/2$

Section 7.4

1 $x\sin x + \cos x + C$ **3** $t^2\sin t + 2t\cos t - 2\sin t + C$
5 $-\frac{1}{2}t\cos(2t-1) + \frac{1}{4}\sin(2t-1) + C$
7 $-\dfrac{x^2}{4}\cos(4x) + \dfrac{x}{8}\sin(4x) + \dfrac{1}{32}\cos(4x) + C$
9 $\frac{1}{4}x^4\operatorname{arcsec} x - \frac{1}{12}(x^2-1)^{3/2} - \frac{1}{4}\sqrt{x^2-1} + C$
11 $-2\sqrt{x}\cos(\sqrt{x}) + 2\sin(\sqrt{x}) + C$ **13** $(x+1)\arctan(\sqrt{x}) - \sqrt{x} + C$
15 $x^2\sqrt{x^2-1} - \frac{2}{3}(x^2-1)^{3/2} + C$ or $\frac{1}{3}(x^2-1)^{3/2} + \sqrt{x^2-1} + C$ or $(\frac{1}{3}x^2 + \frac{2}{3})\sqrt{x^2-1} + C$
17 $-\frac{1}{4}x\cos(2x) + \frac{1}{8}\sin(2x) + C$ or $\frac{1}{2}x\sin^2 x - \frac{1}{4}x + \frac{1}{4}\sin x\cos x + C$
19 $\frac{2}{3}\sin^3\theta + C$ or $\frac{1}{3}[\cos\theta\sin(2\theta) - 2\sin\theta(\cos(2\theta)] + C$
21 $\frac{1}{8}\cos(4x) - \frac{1}{12}\cos(6x) + C$ or $\frac{5}{24}\sin x\sin(5x) + \frac{1}{24}\cos x\cos(5x) + C$
23 $\frac{1}{2}\sin(t^2) - \frac{1}{2}t^2\cos(t^2) + C$ **25** $\dfrac{1}{x}\cos\left(\dfrac{1}{x}\right) - \sin\left(\dfrac{1}{x}\right) + C$
27 $(t^2+4)^{3/2}\left(\dfrac{t^2}{5} - \dfrac{8}{15}\right) + C$ or $\dfrac{1}{3}t^2(t^2+4)^{3/2} - \dfrac{2}{15}(t^2+4)^{5/2} + C$ or $-\dfrac{4}{3}(t^2+4)^{3/2} + \dfrac{1}{5}(t^2+4)^{5/2} + C$ **29** $(\pi/2) - 1$ **31** $\pi/2$ **33** 1/2
35 $\dfrac{2}{3}\pi - \dfrac{\sqrt{3}}{2}$

Section 7.5

1 $(1/\cos t) + \cos t + C$ **3** $-\cot x - x + C$ **5** $\frac{1}{4}\cos^3 x \sin x + \frac{3}{8}\sin x \cos x + \frac{3}{8}x + C$ or $\frac{3}{8}x + \frac{1}{4}\sin(2x) + \frac{1}{32}\sin(4x) + C$ **7** $\frac{1}{6}\tan^6 x + \frac{1}{4}\tan^4 x + C$ or $\frac{1}{6}\sec^6 x - \frac{1}{4}\sec^4 x + C$ **9** $\frac{1}{3}\sin^3 x - \frac{1}{5}\sin^5 x + C$ **11** $-\frac{1}{3}\cot^3\theta + C$

13 $\frac{2}{9}(\tan x)^{9/2} + \frac{2}{5}(\tan x)^{5/2} + C$ **15** $\tan\theta - \cot\theta + C$ or $-2\cot(2\theta) + C$

17 $-\cot\theta + \csc\theta + C$ **19** $4/3$ **21** $\dfrac{\pi}{4} - \dfrac{2}{3}$ **23** $3\pi/8$

25 $\cos(\sqrt{x})\sin(\sqrt{x}) + \sqrt{x} + C$ or $\frac{1}{2}\sin(2\sqrt{x}) + \sqrt{x} + C$

27 $-x\cos x + \frac{1}{3}x\cos^3 x + \frac{2}{3}\sin x + \frac{1}{9}\sin^3 x + C$

29 $\frac{1}{3}x\sin^3 x + \frac{1}{3}\cos x - \frac{1}{9}\cos^3 x + C$ **31** $\frac{1}{9}\tan^9\theta + \frac{2}{7}\tan^7\theta + \frac{1}{5}\tan^5\theta + C$

33 $\frac{1}{2}\sec x\tan x + \frac{1}{2}\int \sec x\,dx$ **35** $\frac{1}{2}\sec x\tan x - \frac{1}{2}\int \sec x\,dx$

37 $-\frac{1}{4}\csc^4 x\cos x + \frac{1}{8}\csc^2 x\cos x - \frac{1}{8}\int \csc x\,dx$ **39** $\int \sec x\,dx + \int \csc x\,dx$

41 $\int x^n \sin x\,dx = -x^n\cos x + n\int x^{n-1}\cos x\,dx = -x^n\cos x + nx^{n-1}\sin x - n(n-1)\int x^{n-2}\sin x\,dx$

43 (a) $\pi^2/16$ (b) $\pi^2/4$

Section 7.6

1 $\frac{1}{2}\arcsin(2x) + C$ **3** $\frac{1}{3}(9 + x^2)^{3/2} - 9(9 + x^2)^{1/2} + C$ or $\sqrt{9 + x^2}(\frac{1}{3}x^2 - 6) + C$

5 $\dfrac{x}{4\sqrt{4 - x^2}} + C$ **7** $\arccos\left(\dfrac{\cos\theta}{\sqrt{2}}\right) + C$ or $-\arcsin\left(\dfrac{\cos\theta}{\sqrt{2}}\right) + C$

9 $-\dfrac{1}{x} - \arctan x + C$ **11** $2\arcsin(x/2) - \frac{1}{2}x\sqrt{4 - x^2} + C$

13 $\frac{1}{8}\arcsin x - \frac{1}{4}x(1 - x^2)^{3/2} + \frac{1}{8}x\sqrt{1 - x^2} + C$

15 $2\arcsin\left(\dfrac{x - 2}{2}\right) + \dfrac{1}{2}(x - 2)\sqrt{4x - x^2} + C$ **17** $\frac{1}{48}(4x^2 - 1)^{3/2} + \frac{1}{16}\sqrt{4x^2 - 1} + C$ or $\sqrt{4x^2 - 1}\,(\frac{1}{24} - \frac{1}{12}x^2) + C$ **19** $\frac{1}{3}(a^2 - x^2)^{3/2} - a^2\sqrt{a^2 - x^2} + C$ or $-\frac{1}{3}\sqrt{a^2 - x^2}(2a^2 + x^2) + C$ **21** $\frac{1}{2}\sqrt{x^4 - 1} - \frac{1}{2}\operatorname{arcsec}(x^2) + C$

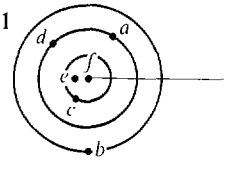
23 $\sqrt{a^2 + x^2} + \dfrac{a^2}{\sqrt{a^2 + x^2}} + C$ **25** $\pi/2$ **27** $1/9$ **29** ∞

31 $(\frac{1}{2}x^2 - \frac{1}{4})\arcsin x + \frac{1}{4}x\sqrt{1 - x^2} + C$ **33** $\frac{1}{3}x^3\arcsin x + \frac{1}{3}\sqrt{1 - x^2} - \frac{1}{9}(1 - x^2)^{3/2} + C$

35 $-\dfrac{\arcsin x}{2x^2} - \dfrac{\sqrt{1 - x^2}}{2x} + C$ **37** $\dfrac{2\pi^2}{3\sqrt{3}} + \dfrac{\pi}{2}$

Section 7.7

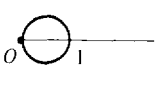
1



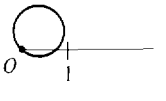
3 $r = \dfrac{2}{\sin\theta - 5\cos\theta}$ **5** $r = 2\sec\theta$ **7** $r\sin\theta = r^2\cos^2\theta + 1$

9 $r\sin\theta = 3r^2\cos^2\theta - 2r\cos\theta$ or $r = \dfrac{\sin\theta + 2\cos\theta}{3\cos^2\theta}$ **11** $r = \sin\theta$

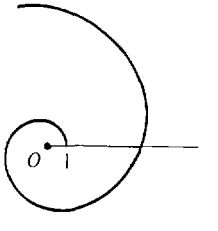
13



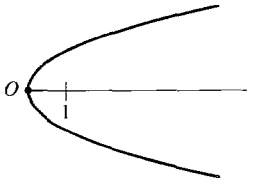
15



17



19



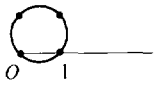
21 $x = \sin(3\theta)\cos\theta,\ y = \sin(3\theta)\sin\theta$ **23** $x = \theta^2\cos\theta,\ y = \theta^2\sin\theta$

Section 7.8

1 θ **3** $-\cot\theta$ **5** $-\dfrac{1+\cot\theta}{\sin\theta}$

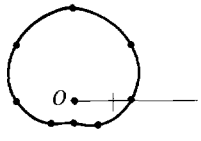
7

θ	r	$dr/d\theta$	$\tan\psi$	$\lvert r\rvert$
0	1	1	1	incr.
$\pi/4$	$\sqrt{2}$	0		max.
$\pi/2$	1	-1	-1	decr.
$3\pi/4$	0	$-\sqrt{2}$		crosses O
π	-1	-1	1	incr.
$5\pi/4$	$-\sqrt{2}$	0		max.
$3\pi/2$	-1	1	-1	decr.
$7\pi/4$	0	$\sqrt{2}$		crosses O
2π	1	1	1	incr.



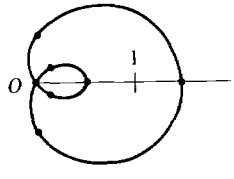
9

θ	r	$dr/d\theta$	$\tan\psi$	$\lvert r\rvert$
0	1.5	1	1.5	incr.
$\pi/4$	2.2	0.7	3.1	incr.
$\pi/2$	2.5	0		max.
$3\pi/4$	2.2	-0.7	-3.1	decr.
π	1.5	-1	-1.5	decr.
$5\pi/4$	0.8	-0.7	-1.1	decr.
$3\pi/2$	0.5	0		min.
$7\pi/4$	0.8	0.7	1.1	incr.
2π	1.5	1	1.5	incr.



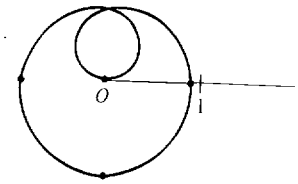
11

θ	r	$dr/d\theta$	$\tan\psi$	$\lvert r\rvert$
0	1.5	0		max.
$\pi/2$	0.5	-1	-0.5	decr.
$2\pi/3$	0	-0.9		crosses O
$3\pi/4$	-0.2	-0.7	0.3	incr.
π	-0.5	0		max.
$5\pi/4$	-0.2	0.7	-0.3	decr.
$4\pi/3$	0	0.9		crosses O
$3\pi/2$	0.5	1	0.5	incr.
2π	1.5	0		max.



13

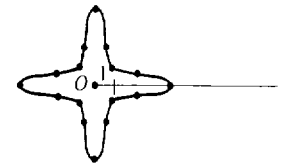
θ	r	$dr/d\theta$	$\tan\psi$	$\lvert r\rvert$
0	0	$\frac{1}{3}$		crosses O
π	0.9	$\frac{1}{6}$	5	incr.
1.5π	1	0		max.
2π	0.9	$-\frac{1}{6}$	-5	decr.
3π	0	$-\frac{1}{3}$		crosses O
4π	-0.9	$-\frac{1}{6}$	5	incr.
4.5π	-1	0		max.
5π	-0.9	$\frac{1}{6}$	-5	decr.
6π	0	$\frac{1}{3}$		crosses O



15

θ	r	$dr/d\theta$	$\tan\psi$	$\lvert r\rvert$
0	4	0		max.
$\pi/8$	2.5	-6	-0.4	decr.
$2\pi/8$	1	0		min.
$3\pi/8$	2.5	6	0.4	incr.
$4\pi/8$	4	0		max.
$5\pi/8$	2.5	-6	-0.4	decr.
$6\pi/8$	1	0		min.
$7\pi/8$	2.5	6	0.4	incr.
π	4	0		max.

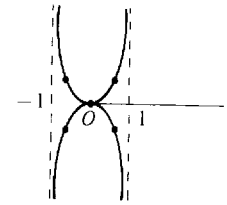
repeats



17

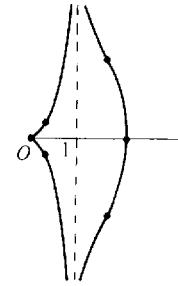
θ	r	$dr/d\theta$	$\tan\psi$	$\lvert r\rvert$
0	0	1		crosses O
$\pi/4$	1	2	$\frac{1}{2}$	incr.
$\lim_{\theta\to\pi/2^-}$	∞			$x\to 1$
$\lim_{\theta\to\pi/2^+}$	$-\infty$			$x\to 1$
$3\pi/4$	-1	2	$-\frac{1}{2}$	decr.
π	0	1		crosses O

repeats, with $x\to -1$ as $\theta\to 3\pi/2$



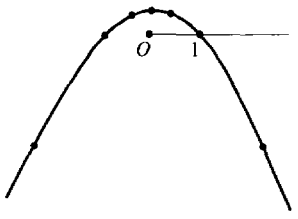
19

θ	r	$dr/d\theta$	$\tan\psi$	$\lvert r\rvert$
0	2	0		min.
$\pi/4$	2.4	2.4	1	incr.
$\lim_{\theta\to\pi/2^-}$	∞			$x\to 1$
$\lim_{\theta\to\pi/2^+}$	$-\infty$			$x\to 1$
$3\pi/4$	-0.4	0.4	-1	decr.
π	0	0		cusp at O
$5\pi/4$	-0.4	-0.4	1	incr.
$\lim_{\theta\to 3\pi/2^-}$	$-\infty$			$x\to 1$
$\lim_{\theta\to 3\pi/2^+}$	∞			$x\to 1$
$7\pi/4$	2.4	-2.4	-1	decr.
2π	2	0		min.



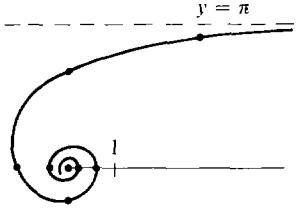
21

θ	r	$dr/d\theta$	$\tan\psi$	$\lvert r\rvert$
0	1	-1	-1	decr.
$\pi/4$	0.6	-0.3	-2	decr.
$\pi/2$	0.5	0		min.
$3\pi/4$	0.6	0.3	2	incr.
π	1	1	1	incr.
$5\pi/4$	3.4	8	0.4	incr.
$\lim_{\theta\to 3\pi/2^-}$	∞			$x\to-\infty$
$\lim_{\theta\to 3\pi/2^+}$	∞			$x\to\infty$
$7\pi/4$	3.4	-8	-0.4	decr.
2π	1	-1	-1	decr.



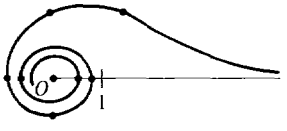
23

θ	r	$dr/d\theta$	$\tan\psi$	$\lvert r\rvert$
$\lim_{\theta\to 0^+}$	∞			$y\to\pi$
$\pi/4$	4	$-16/\pi$	$-\pi/4$	decr.
$\pi/2$	2	$-4/\pi$	$-\pi/2$	decr.
π	1	$-1/\pi$	$-\pi$	decr.
$3\pi/2$	$\frac{2}{3}$	$-\frac{4}{9}\pi$	$-3\pi/2$	decr.
2π	$\frac{1}{2}$	$-\frac{1}{4}\pi$	-2π	decr.
3π	$\frac{1}{3}$	$-\frac{1}{9}\pi$	-3π	decr.
4π	$\frac{1}{4}$	$-\frac{1}{16}\pi$	-4π	decr.



25

θ	r	$dr/d\theta$	$\tan\psi$	$\lvert r\rvert$
$\lim_{\theta\to 0^+}$	∞			$y\to O$
$\pi/4$	2	$-4/\pi$	$-\pi/2$	decr.
$\pi/2$	$\sqrt{2}$	$-\sqrt{2}/\pi$	$-\pi$	decr.
π	1	$-\frac{1}{2}\pi$	-2π	decr.
$3\pi/2$	$\sqrt{\frac{2}{3}}$	–	–	decr.
2π	$1/\sqrt{2}$	–	–	decr.
3π	$1/\sqrt{3}$	–	–	decr.
4π	$\frac{1}{2}$	–	–	decr.



27 x: max of $\sqrt{32/27}$ at $\theta = \arcsin(1/\sqrt{3})$, $2\pi - \arcsin(1/\sqrt{3})$; min of $-\sqrt{32/27}$ at $\theta = \pi + \arcsin(1/\sqrt{3})$, $\pi - \arcsin(1/\sqrt{3})$
y: max of 2 at $\theta = \pi/2$; min of -2 at $\theta = 3\pi/2$

29 x: max of $\frac{5}{2}$ at $\theta = 0$; min of $-\frac{9}{16}$ at $\theta = \arccos(-\frac{3}{4})$, $2\pi - \arccos(-\frac{3}{4})$

y: max of $\sin\theta_0(\frac{3}{2} + \cos\theta_0)$ at $\theta = \theta_0 = \arccos\left(\dfrac{\sqrt{41}-3}{8}\right)$; min of $-\sin\theta_0\left(\dfrac{3}{2} + \cos\theta_0\right)$ at $\theta = 2\pi - \arccos\left(\dfrac{\sqrt{41}-3}{8}\right)$

31 $\left(\frac{1}{2}, \frac{\pi}{12}\right)$, $\left(\frac{1}{2}, \frac{5\pi}{12}\right)$, $\left(\frac{1}{2}, \frac{13\pi}{12}\right)$, $\left(\frac{1}{2}, \frac{17\pi}{12}\right)$, $\left(\frac{1}{2}, \frac{7\pi}{12}\right)$, $\left(\frac{1}{2}, \frac{11\pi}{12}\right)$, $\left(\frac{1}{2}, \frac{19\pi}{12}\right)$, $\left(\frac{1}{2}, \frac{23\pi}{12}\right)$

Section 7.9

1 πa^2 **3** 1 **5** $2 - \dfrac{\pi}{2}$ **7** $\dfrac{3\pi}{16}$ **9** $\dfrac{\pi}{4} - \dfrac{3\sqrt{3}}{8}$ **11** $\dfrac{\pi}{12} + \dfrac{\sqrt{3}}{16}$ **13** $\dfrac{3}{2} - \dfrac{\pi}{4}$

15 $\dfrac{\pi}{3} - \dfrac{\sqrt{3}}{4}$ **17** π^2 **19** $\dfrac{7\pi}{12} - \sqrt{3}$ **21** $\dfrac{1}{2}\displaystyle\int_a^b (g(\theta))^2 - (f(\theta))^2\, d\theta$

Section 7.10

1 14π 3 2 5 $\dfrac{2048 - 493\sqrt{17}}{15} \sim 1.02$ 7 4 9 4

11 $\displaystyle\int_0^{2\pi} \sqrt{\sin^2(2\theta) + 4\cos^2(2\theta)}\, d\theta$ 13 $\displaystyle\int_0^b \sqrt{\theta^2 + 1}\, d\theta$ 17 $\pi\sqrt{a^2 + b^2}\left(a + \dfrac{b\pi}{2}\right)$

19 $\pi\sqrt{2}$ 21 $\dfrac{\pi}{5}(8 - \sqrt{2})$

Extra Problems for Chapter 7

1 $1 + \cos x$ 3 $\dfrac{\cos\theta}{2\sqrt{\theta}} - \sqrt{\theta}\sin\theta$ 5 4/3 7 $-\sin(\cos\theta) + C$ 9 8

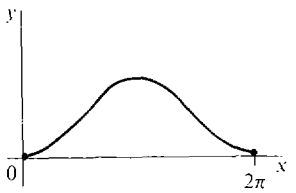
11 $-600/29$ radians/hr 13 $-\dfrac{1}{2\sqrt{x}\sqrt{1-x}}$ 15 $\dfrac{1}{1+t^2} - 1$ or $-\dfrac{t^2}{1+t^2}$ 17 1

19 $\operatorname{arcsec}(x-1) + C$ 21 $\frac{1}{3}(x^2+1)^{3/2} - (x^2+1)^{1/2} + C = x^2(x^2+1)^{1/2} - \frac{2}{3}(x^2+1)^{3/2} + C = (x^2+1)^{1/2}(\frac{1}{3}x^2 - \frac{2}{3}) + C$ 23 $2\sin 1 + 2\cos 1 - 2$

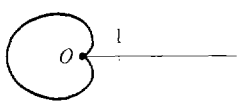
25 $\pi\left(1 - \dfrac{\pi}{4}\right)$ 27 $\dfrac{\sec^9\theta}{9} - \dfrac{2\sec^7\theta}{7} + \dfrac{\sec^5\theta}{5} + C$

29 $-\dfrac{\sqrt{2-x^2}}{x} - \arcsin\left(\dfrac{x}{\sqrt{2}}\right) + C$

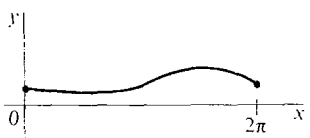
31 (a)



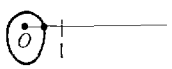
(b)



33 (a)



(b)



35 $19\pi/8$ 37 $(3\pi/2) - 4$ 39 $4\sqrt{2}\pi/5$

Section 8.1

9 0 11 ∞ 13 0 15 ∞ 17 27 19 ∞ 21 1/6 23 $1/(2\pi)$

Section 8.2

1 x 3 $-x^2$ 5 x/y^2 7 $\frac{2}{3}\log_b x$ 9 $\frac{1}{2}(\log_b x + \log_b y)$ 11 2 13 1/2

15 $x = \log_5 3$ 17 $x = -\frac{2}{3}$ 19 $x = 5^{1/3}$ 21 $x = 2, x = 3$

23 $x = 2^{1/(1-\log_3 2)} = 3^{1/(\log_2 3 - 1)}$ 25 $-\infty$ 27 $-\infty$ 29 $-\infty$

Section 8.3

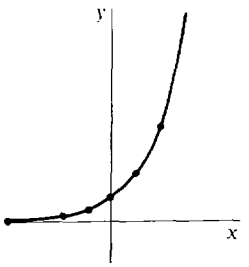
1 $3e^{3x+4}$ 3 $-4^{-x}\ln 4$ 5 $e^t\cos(e^t)$ 7 $2^{t^2+1}t\ln 2$ 9 $e^t e^{(e^t)}$

11 $\dfrac{\ln 3}{2\sqrt{x}}3^{\sqrt{x}}$ 13 $-\dfrac{e^{x+y}}{e^{x+y} + \sin y}$ 15 $\dfrac{1}{2\sqrt{e^t}(t^{-1} - t^{-2})}$ or $\dfrac{t^2}{2\sqrt{e^t}(t-1)}$ 17 ∞

19 1 21 $-\infty$ 23 e^c 25 e^c

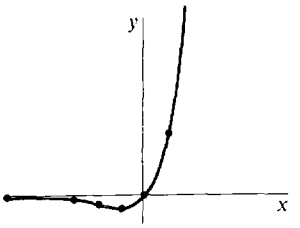
27

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	0	0			
-2	$1/4$	$(\ln 2)/4$	$+$	incr.	$\cup$
-1	$1/2$	$(\ln 2)/2$	$+$	incr.	$\cup$
0	1	$\ln 2$	$+$	incr.	$\cup$
1	2	$2\ln 2$	$+$	incr.	$\cup$
2	4	$4\ln 2$	$+$	incr.	$\cup$
$\lim_{x\to\infty}$	∞	∞			



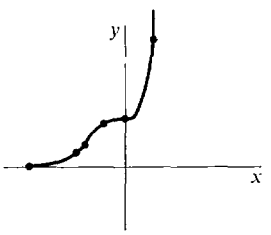
29

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	0	0			
-3	$-3e^{-3}$	$-2e^{-3}$	$-$	decr.	$\cap$
-2	$-2e^{-2}$	$-e^{-2}$	0	decr.	infl.
-1	$-e^{-1}$	0	$+$	min.	$\cup$
0	0	1	$+$	incr.	$\cup$
1	e	$2e$	$+$	incr.	$\cup$
$\lim_{x\to\infty}$	∞	∞			



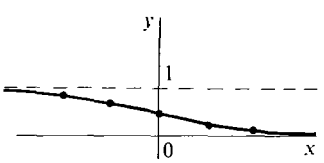
31

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	0	0			
-2	e^{-8}	$12e^{-8}$	$+$	incr.	$\cup$
-1	e^{-1}	$3e^{-1}$	$+$	incr.	$\cup$
$-(\frac{2}{3})^{1/3}$	$e^{-2/3}$	$+$	0	incr.	infl.
$-\frac{1}{2}$	$e^{-1/8}$	$\frac{3}{4}e^{-1/8}$	$-$	incr.	$\cap$
0	1	0	0	horiz.	infl.
1	e	$3e$	$+$	incr.	$\cup$
$\lim_{x\to\infty}$	∞	∞			



33

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	1	0			
-2	0.88	-0.1	$-$	decr.	$\cap$
-1	0.73	-0.2	$-$	decr.	$\cap$
0	0.5	-0.25	0	decr.	infl.
1	0.27	-0.2	$+$	decr.	$\cup$
2	0.12	-0.1	$+$	decr.	$\cup$
$\lim_{x\to\infty}$	0	0			



35 $\frac{1}{2}e^{2x} + C$ **37** $-\frac{1}{2}e^{-x^2} + C$ **39** $\frac{1}{3}(1 + e^{2x})^{3/2} + C$ **41** $xe^x - e^x + C$

43 $\frac{1}{2}e^x(\sin x - \cos x) + C$ **45** $\dfrac{e^{10} - 1}{5}$ **47** ∞

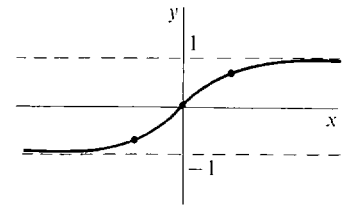
49 $\dfrac{1}{r^2}$ if $r > 0$, ∞ if $r \le 0$ **51** (a) $\dfrac{\pi}{2}(e^2 - 1)$ (b) 2π **53** $\sqrt{2}(e^{2\pi} - 1)$

Section 8.4

1 $3\cosh(3x)$ **3** $-\tanh x \operatorname{sech} x$ **5** 1 **7** 0

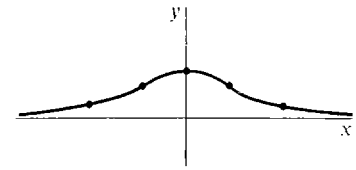
9

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	-1	0			
-1	-0.76	0.4	+	incr.	$\cup$
0	0	1	0	incr.	infl.
1	0.76	0.4	−	incr.	$\cap$
$\lim_{x\to\infty}$	1	0			



11

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to-\infty}$	0	0			
-2	0.27	0.26	+	incr.	$\cup$
-0.88	0.71	0.5	0	incr.	infl.
0	1	0	−	max.	$\cap$
0.88	0.71	-0.5	0	decr.	infl.
2	0.27	-0.26	+	decr.	$\cup$
$\lim_{x\to\infty}$	0	0			



13 $\frac{\sinh^2 x}{2} + C$ or $\frac{\cosh^2 x}{2} + C$ **15** $x\cosh x - \sinh x + C$

17 $\frac{1}{2}x\sinh x\cosh x + \frac{1}{4}x^2 - \frac{1}{4}\sinh^2 x + C$ or $\frac{1}{4}x\sinh(2x) - \frac{1}{8}\cosh(2x) + \frac{1}{4}x^2 + C$ **19** ∞

23 (a) $\frac{\pi}{8}(4 + e^2 - e^{-2})$ (b) $2\pi(1 - e^{-1})$ **25** $50{,}000(e^2 - 1) \sim 320{,}000$ dollars

27 (a) $10^6(90e^{0.2} - 110) \sim -74{,}000$ dollars (b) $10^6(90e^{0.3} - 120) \sim 1{,}490{,}000$ dollars

Section 8.5

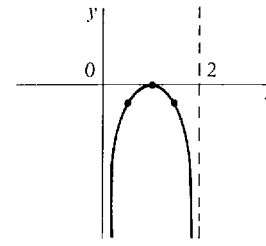
1 $(3/x)(\ln x)^2$ **3** $-\tan x$ **5** $\ln t$ **7** $t^{-2}(1 - \ln t)$ **9** $\frac{1}{x\ln 2}$

11 $\frac{1}{y} + \frac{3}{2(3y+1)}$ **13** $y - \frac{y}{x}$ **15** $\frac{1}{x + y - 1}$ **17** 0 **19** 0 **21** $\ln a$

23 1 **25** 1

27

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to0^+}$	$-\infty$	∞			
$\frac{1}{2}$	-0.3	$\frac{4}{3}$	−	incr.	$\cap$
1	0	0	−	max.	$\cap$
$\frac{3}{2}$	0.3	$-\frac{4}{3}$	−	decr.	$\cap$
$\lim_{x\to2^-}$	$-\infty$	$-\infty$			



29 $\frac{1}{2}\ln|2x + 3| + C$ **31** $2x + 2\ln|x - 1| + C$ **33** $\frac{1}{2}(\ln x)^2 + C$ **35** $\ln|\ln t| + C$

37 $\ln x(\ln(\ln x) - 1) + C$ **39** $\frac{x^{n+1}}{n+1}\ln x - \frac{x^{n+1}}{(n+1)^2} + C$

41 $x(\ln x)^3 - 3x(\ln x)^2 + 6x\ln x - 6x + C$ **43** $\sin(\ln x) + C$ **45** $10 - \ln(11)$

47 1 **49** $-\infty$ **51** ∞ **53** (a) $\pi(e-2)$ (b) $\frac{\pi}{2}(e^2+1)$

55 $\sqrt{e^2+1}-\sqrt{2}+1+\ln\left(\dfrac{1+\sqrt{2}}{1+\sqrt{e^2+1}}\right)$

Section 8.6

1 $y=-\dfrac{2}{x^2+C}$ **3** $y=\pm\sqrt{\frac{2}{3}x^3+C}$ **5** $y=-\ln\left(\dfrac{C-x^2}{2}\right)$

7 $y=\ln(e^x+C)$ **9** $y=\dfrac{1}{\pm\sqrt{2\cos x+C}}$ **11** $y=\dfrac{x^3}{3}+\dfrac{x^2}{2}+Ax+B$

13 $y=Ax+B$ **15** $y=A\sinh(\sqrt{3}x)+B\cosh(\sqrt{3}x)$ or $y=Ae^{\sqrt{3}x}+Be^{-\sqrt{3}x}$

17 $y=10^7e^{(0.01)t}$ **19** $\dfrac{6\ln 10}{\ln 2}\text{ min}\sim 19.93\text{ min}$ **21** $10^5\times(1.15)^4\sim 174{,}900$

23 $t=\dfrac{\ln(0.5)}{\ln(0.9)}\sim 6.576$ years **25** $y=e^t+e^{-t}$ **27** $y=\cos t-2\sin t$

29 $y=10^{6.5}\sqrt{t}$ **31** $y=\dfrac{10^8}{1+9e^{-t}}$ **33** (b) $y_0=L/2$

35 (a) $y=10^7-6\times 10^6 2^{-t}$ (b) $y=10^7+3\times 10^6 3^{-t}$

37 $y^2-x^2=C$ or $y=\pm\sqrt{x^2+C}$

Section 8.7

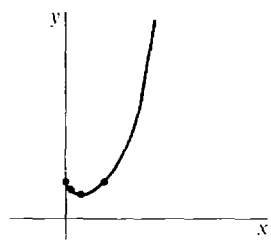
1 $\left(\dfrac{3x-2}{4x+3}\right)\left[\dfrac{3}{3x-2}-\dfrac{4}{4x+3}\right]$

3 $\dfrac{(x^2+1)\sqrt{3x+4}}{(2x-3)\sqrt{x^2-4}}\left[\dfrac{2x}{x^2+1}+\dfrac{3}{2(3x+4)}-\dfrac{2}{2x-3}-\dfrac{x}{x^2-4}\right]$

5 $(x-1)^{x^2+1}\left[2x\ln(x-1)+\dfrac{x^2+1}{x-1}\right]$ **7** $e^{(e^x)}e^x$ **9** $\sqrt[t]{t}\left[\dfrac{1}{t^2}-\dfrac{1}{t^2}\ln t\right]$

11

x	$f(x)$	$f'(x)$	$f''(x)$		
$\lim_{x\to 0^+}$	1	$-\infty$			
1/10	$10^{-0.1}$	$-$	$+$	decr.	$\cup$
$1/e$	$e^{-1/e}$	0	$+$	min.	$\cup$
1	1	1	$+$	incr.	$\cup$
$\lim_{x\to\infty}$	∞	∞			



15 $\ln|\sin\theta|+C$ **17** $\frac{1}{3}\ln|\sec(3\theta)|+C$

19 $\frac{1}{4}\sec^4\theta\sin\theta+\frac{3}{8}\sec^2\theta\sin\theta+\frac{3}{8}\ln|\sec\theta+\tan\theta|+C$ **21** $\ln|\tan x|+C$

23 $\ln|\sec x+\tan x|-\sin x+C$ **25** $\frac{1}{2}x\sqrt{x^2-1}-\frac{1}{2}\ln|x+\sqrt{x^2-1}|+C$

27 $\frac{1}{2}\ln\left|\dfrac{x}{\sqrt{4-x^2}+2}\right|+C$ or $\frac{1}{4}\ln\left|\dfrac{2-\sqrt{4-x^2}}{2+\sqrt{4-x^2}}\right|+C$ **29** $\frac{1}{4}\ln\left|\dfrac{x-2}{x+2}\right|+C$

31 $\sqrt{x^2-1}-\operatorname{arcsec}x+C$ or $\sqrt{x^2-1}-\arctan\sqrt{x^2-1}+C$

33 $\dfrac{x}{4}(x^2+1)^{3/2}-\dfrac{x}{8}(x^2+1)^{1/2}-\dfrac{1}{8}\ln(x+\sqrt{x^2+1})+C$ or

$x(x^2+1)^{1/2}\left(\dfrac{1}{4}x^2+\dfrac{1}{8}\right)-\dfrac{1}{8}\ln(x+\sqrt{x^2+1})+C$

35 $-\dfrac{\arcsin x}{x} - \ln\left|\dfrac{1+\sqrt{1-x^2}}{x}\right| + C$ or $-\dfrac{\arcsin x}{x} + \ln\left|\dfrac{1-\sqrt{1-x^2}}{x}\right| + C$

37 $x\,\text{arccsc}\,x + \ln(x+\sqrt{x^2-1}) + C,\ x \geq 1$; $x\,\text{arccsc}\,x - \ln|x+\sqrt{x^2-1}| + C,\ x \leq -1$

39 $\sqrt{5} + \frac{1}{2}\ln(2+\sqrt{5}) \sim 2.96$ **41** $\frac{1}{2}a\sqrt{1+a^2} + \frac{1}{2}\ln(a+\sqrt{1+a^2})$

Section 8.8

1 $\frac{1}{2}\ln|2x-7| + C$ **3** $\frac{1}{12}\ln|x-4| - \frac{1}{12}\ln|x| + C$ **5** $-\frac{1}{5}\ln|x-1| + \frac{11}{5}\ln|x+4| + C$

7 $\dfrac{x^2}{2} - 3x + \dfrac{1}{4}\ln|x| + \dfrac{51}{4}\ln|x+4| + C$ **9** $-\dfrac{1}{2(x+1)^2} + C$

11 $\ln|x-1| - \dfrac{1}{x-1} - \dfrac{1}{2(x-1)^2} + C$ **13** $-\ln|x| + \frac{1}{2}\ln|x+1| + \frac{1}{2}\ln|x-1| + C$

15 $x + \ln|x| - \dfrac{1}{x} + C$ **17** $x - 4\arctan(x/4) + C$ **19** $\frac{5}{4}\ln|x-3| - \frac{1}{4}\ln|x+1| + C$

21 $\frac{1}{3}x^3 - x + \arctan x + C$ **23** $\arctan x - (1/\sqrt{2})\arctan(x/\sqrt{2}) + C$

25 $-x^{-1} - \arctan x + C$ **27** $\dfrac{1}{3}\ln|x+1| - \dfrac{1}{6}\ln|x^2-x+1| + \dfrac{1}{\sqrt{3}}\arctan\left(\dfrac{2x-1}{\sqrt{3}}\right) + C$

29 $\dfrac{x^2}{2} - \dfrac{3}{4}\ln|x+1| + \dfrac{5}{4}\ln|x-1| - \dfrac{1}{4}\ln|x^2+1| + \arctan x + C$

31 $\ln|x| - \dfrac{1}{2}\ln|x^2+1| - \dfrac{\arctan x}{x} + C$

Section 8.9

1 $-3\cos x + 4\sin x + C$ **3** $\frac{3}{4}(x^2-1)^{2/3} + C$ **5** $\frac{1}{3}[(x+2)^{3/2} + x^{3/2}] + C$

7 $2(1+\sqrt{x}) - 2\ln(1+\sqrt{x}) + C$ or $2\sqrt{x} - 2\ln(1+\sqrt{x}) + C$

9 $-(\sqrt{4x+1}/x) + C$ **11** $-2\cos(\sqrt{x}) + C$

13 $\frac{2}{7}(x-3)^{7/2} + \frac{12}{5}(x-3)^{5/2} + 6(x-3)^{3/2} + C$

15 $\frac{1}{3}[(3x+4)\ln(3x+4) - (3x+4)] + C$ or $\frac{1}{3}(3x+4)\ln(3x+4) - x + C$

17 $x\tan x - \ln|\sec x| - (x^2/2) + C$ **19** $-\frac{1}{6}\cos(3x^2+1) + C$

21 $2x\ln|x| - 3x + (x+1)\ln(x+1) + C$ **23** $\cos\theta - \cos\theta\ln(\cos\theta) + C$

25 $\ln(2-\cos\theta) + C$ **27** $\frac{1}{4}(e^x+1)^4 + C$ **29** $2\sin(\sqrt{x}) - 2\sqrt{x}\cos(\sqrt{x}) + C$

31 $\ln(1+\cosh x) + C$ **33** $-\dfrac{\ln x}{1+x} + \ln\left(\dfrac{x}{1+x}\right) + C$

35 $\frac{4}{5}(1-\cos x)^{5/2} - \frac{2}{7}(1-\cos x)^{7/2} + C$ **37** $\dfrac{1}{\sqrt{2}}\ln\left|\dfrac{x}{\sqrt{2}+\sqrt{2+x^2}}\right| + C$

39 $4\arcsin\left(\dfrac{\sqrt{x}}{2}\right) + \sqrt{x}\sqrt{4-x} - \dfrac{1}{2}\sqrt{x}(4-x)^{3/2} + C$ or

$\dfrac{1}{2}(x-2)\sqrt{x}\sqrt{4-x} + 2\arcsin\left(\dfrac{x-2}{2}\right) + C$

41 $\frac{1}{5}[(5x-2)\arcsin(5x-2) + \sqrt{1-(5x-2)^2}] + C$ **43** $\frac{1}{2}e^x(\sin x + \cos x) + C$

45 $(x^3/3) - x + 2\arctan x + C$ **47** $\frac{1}{2}x^2\,\text{arcsec}\,(x^2) - \frac{1}{2}\ln(x^2+\sqrt{x^4-1}) + C$

49 $2x\ln x + \dfrac{4x-1}{8}\ln(4x-1) - \dfrac{5}{2}x + C$ **51** $2\ln|2x+\sqrt{4x^2-1}| - \dfrac{\sqrt{4x^2-1}}{x} + C$

53 $(x+1)\arctan(\sqrt{x}) - \sqrt{x} + C$ **55** $\frac{1}{8}\ln|\sec(4x^2+7) + \tan(4x^2+7)| + C$

57 $-\frac{1}{243}\sqrt{1-9x^2}(2+9x^2) + C$ **59** $(\sqrt{x^2-3}/3x) + C$

61 $3x^{2/3}\sin(\sqrt[3]{x}) + 6(\sqrt[3]{x})\cos(\sqrt[3]{x}) - 6\sin(\sqrt[3]{x}) + C$

63 $\frac{1}{3}x^3(1-x^2)^{-3/2} + x(1-x^2)^{-1/2} + C$ **65** $\dfrac{x}{5}(\cos^2(\ln x) + \sin(2\ln x) + 2) + C$

Extra Problems for Chapter 8

1 $-\infty$ **3** $-e^{\cos\theta}\sin\theta$ **5** $-3\operatorname{csch}^3 x\coth x$ **7** $-\dfrac{1}{\ln 3}\cos(3^x)+C$

9 $\frac{1}{2}e^x\sqrt{1-e^{2x}}+\frac{1}{2}\arcsin(e^x)+C$ or $\frac{1}{2}e^x\sqrt{1-e^{2x}}-\frac{1}{2}\arccos(e^x)+C$

11 $\frac{1}{4}e^{2x}-\frac{1}{2}x+C$ **13** $\dfrac{8x}{x^2-1}$ **15** $\dfrac{3}{3x+2}+\dfrac{5}{5x-4}-\dfrac{2}{2x-1}-\dfrac{2x}{x^2+1}$ **17** e^2

19 $(1/a)\ln|x|-(b/a)\ln|a+bx|+C$ **21** ∞ **23** $y=\pm\sqrt{ax^2+C}$

25 $P=CV^{-1/k}$ **27** air temp. $=60°$, $y=60+80\cdot 2^{-t/10}$

29 $(4t+1)^t(t-3)^{2t+1}\left\{\ln[(t-3)^2(4t+1)]+\dfrac{4t}{4t+1}+\dfrac{2t+1}{t-3}\right\}$ **31** $\ln|\cosh x|+C$

33 $\frac{2}{5}(x+1)^{5/2}+C$ **35** $\pi(2\sqrt{2}+\ln|\sqrt{2}+1|-\ln|\sqrt{2}-1|)$ or $2\pi(\sqrt{2}+\ln|\sqrt{2}+1|)$

37 $e^{0.03}\sim 1.03$, error ≤ 0.0005 **39** $\ln 6\sim\frac{1}{2}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{12}=\frac{28}{15}$, error $\le\frac{1}{2}$

41 $\bar{x}=\dfrac{2\ln 2-\frac{3}{4}}{2\ln 2-1}$, $\bar{y}=\dfrac{(\ln 2-1)^2}{2\ln 2-1}$

43 $\pi[e\sqrt{1+e^2}-\sqrt{2}+\ln(e+\sqrt{1+e^2})-\ln(1+\sqrt{2})]$

Section 9.1

1 2^{-n} **3** $(-1)^n n$ **5** $2-(1/2^{n-1})$ **7** $2^{2^{(n-1)}}$ **9** diverges **11** 1
13 0 **15** diverges **17** diverges **19** $1/e$ **21** 0 **23** -1 **25** diverges
27 diverges **29** 0

Section 9.2

1 $\frac{3}{2}(1-(1/3)^n)$, converges to $\frac{3}{2}$ **3** $4(1-(3/4)^n)$, converges to 4

5 $1-\dfrac{1}{(n+1)!}$, converges to 1 **7** $1-\dfrac{1}{n+1}$, converges to 1

9 n even: $-\dfrac{n}{2}$, n odd: $\dfrac{n}{2}+\dfrac{1}{2}$, diverges **11** $1-(n+1)^{-2}$, converges to 1

13 $\dfrac{1}{2}\left(1-\dfrac{1}{2n+1}\right)$, converges to $\dfrac{1}{2}$ **15** diverges because $\lim_{n\to\infty} a_n=\frac{1}{2}$

17 diverges because for infinite H, $S_{2H}\not\approx S_{2\cdot 2H}$

19 diverges because for infinite H, $S_{2H}\not\approx S_H$ **21** A: 2/3, B: 1/3

23 A: 9/19, B: 6/19; C: 4/19

Section 9.3

1 1/42 **3** 11/4 **5** 5/48 **7** 216/5 **9** 80/9 **11** $5\frac{43}{99}$
13 492.315 + (41/999,000) **15** 1/7

Section 9.4

1 diverges **3** converges **5** converges **7** converges **9** diverges
11 diverges **13** converges **15** diverges **17** converges **19** converges
21 diverges **23** converges **25** converges **27** diverges **29** diverges
31 converges **33** diverges **35** converges **37** converges

Section 9.5

1 diverges **3** diverges **5** converges **7** diverges **9** diverges
11 diverges **13** converges **15** converges **17** converges **19** diverges
21 0.90 **23** 0.37

Section 9.6

1 diverges **3** diverges **5** absolutely converges **7** diverges **9** diverges
11 diverges **13** conditionally converges **15** absolutely converges
17 conditionally converges **19** diverges **21** diverges **23** no information
25 converges **27** diverges **29** converges **31** converges **33** no information
35 converges **37** converges **39** converges **41** no information **43** converges

Section 9.7

1 1 **3** 0 **5** e **7** $4/e^2$ **9** 1 **11** 1 **13** 0 **15** 1/3 **17** ∞
19 ∞ **21** 0 **23** $\sqrt[3]{5}$ **25** 1 **27** $(-1, 1)$ **29** $(-1, 1]$ **31** $[-1/2, 1/2)$
33 $(-\infty, \infty)$ **35** $(-3, -1]$ **37** $(-\infty, \infty)$ **39** $(-1, 1)$ **41** $(-5/4, 5/4)$
43 $(-\sqrt{5}, \sqrt{5})$ **45** $(-\infty, \infty)$

Section 9.8

1 $f'(x) = \sum_{n=1}^{\infty} n\,10^n x^{n-1}$, $\int_0^x f(t)\,dt = \sum_{n=0}^{\infty} \frac{10^n}{n+1} x^{n+1}$

3 $f'(x) = \sum_{n=1}^{\infty} n^{-2} x^{n-1}$, $\int_0^x f(t)\,dt = \sum_{n=1}^{\infty} \frac{n^{-3}}{n+1} x^{n+1}$

5 $f'(x) = \sum_{n=1}^{\infty} (n+1)x^{n-1}$, $\int_0^x f(t)\,dt = \sum_{n=1}^{\infty} \frac{1}{n} x^{n+1}$

7 $f'(x) = \sum_{n=1}^{\infty} \frac{n!}{n^{n-1}} x^{n-1}$, $\int_0^x f(t)\,dt = \sum_{n=1}^{\infty} \frac{n!}{n^n(n+1)} x^{n+1}$

9 $f'(x) = \sum_{n=1}^{\infty} 2nx^{2n-1}$, $\int_0^x f(t)\,dt = \sum_{n=0}^{\infty} \frac{1}{2n+1} x^{2n+1}$ **11** $\sum_{n=0}^{\infty} (-1)^n 3^n x^n$, $r = \frac{1}{3}$

13 $\sum_{n=0}^{\infty} \frac{(-1)^n 4^{2n+1} x^{4n+2}}{2n+1}$, $r = \frac{1}{2}$ **15** $\sum_{n=0}^{\infty} \frac{(-1)^n 2^{n+1} x^{n+2}}{n+1}$, $r = \frac{1}{2}$

17 $\sum_{n=0}^{\infty} \frac{(-1)^n 4^n x^n}{n!}$, $r = \infty$ **19** $\sum_{n=0}^{\infty} \frac{3^{2n+1} x^{2n+1}}{(2n+1)!}$, $r = \infty$

21 $\sum_{n=0}^{\infty} \frac{(-1)^n 2^{n+1} x^{2n+3}}{(n+1)(2n+3)}$, $r = \frac{1}{\sqrt{2}}$ **23** $\sum_{n=0}^{\infty} \frac{x^{3n+1}}{n!(3n+1)}$, $r = \infty$

25 $\sum_{n=0}^{\infty} -\frac{x^{n+3}}{(n+1)(n+3)}$, $r = 1$ **27** $\sum_{n=0}^{\infty} \frac{(-1)^n x^{n+1}}{(n+1)^2}$, $r = 1$

29 $\sum_{n=1}^{\infty} (-1)^{n+1} 2nx^{2n-1}$, $r = 1$ **31** $\sum_{n=0}^{\infty} (-1)^n 2 \cdot x^{4n+1}$, $r = 1$

33 $\sum_{n=0}^{\infty} \frac{(-1)^n (1 + 2^{2n+1}) x^{2n+1}}{2n+1}$, $r = \frac{1}{2}$

Section 9.9

1 0.18232 **3** 0.7788008 **5** 0.4854019 **7** 0.3293740 **9** 1.003009
11 1.098614 **13** $f(x) = x + x^2 + \cdots + x^{n+1} + E, |E| \le 2|x|^{n+2}, f(\frac{1}{2}) = 1$
15 $f(x) = 1 + x^2 + \cdots + x^{2n} + E, |E| \le \frac{4}{3}x^{2n+2}, f(\frac{1}{2}) = \frac{4}{3}$
17 $f(x) = -x - (x^2/2^2) - \cdots - (x^n/n^2) + E, |E| \le 2|x|^{m+1}/(m+1)^2, f(\frac{1}{2}) \sim 0.58$

Section 9.10

1 $f(x) = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \cdots + \frac{(-1)^n x^{2n}}{(2n)!} + \frac{(-1)^{n+1}(\cos t)x^{2n+2}}{(2n+2)!}$, $f\left(\frac{1}{2}\right) \sim 0.8776$

3 $f(x) = 2x - \dfrac{2^3x^3}{3!} + \cdots + \dfrac{(-1)^{n+1}2^{2n+1}x^{2n+1}}{(2n+1)!} + \dfrac{(-1)^n \cos(2t)(2x)^{2n+3}}{(2n+3)!}, f\left(\dfrac{1}{2}\right) \sim 0.8415$

5 $f(x) = x - \dfrac{4x^3}{3!} + \dfrac{4^2x^5}{5!} - \cdots + \dfrac{(-1)^n 4^n x^{2n+1}}{(2n+1)!} + \dfrac{(-1)^{n+1}4^{n+1}(\cos^2 t - \sin^2 t)x^{2n+3}}{(2n+3)!}$,

$f(\frac{1}{2}) \sim 0.4207$

7 $f(x) = 2^{-3} + 3 \cdot 2^{-6}x + \cdots + \dfrac{(-1)^n(1 \cdot 3 \cdots (2n+1))2^{-3(n+1)}x^n}{n!}$

$+ \dfrac{(-1)^{n+1}(1 \cdot 3 \cdots (2n+3))(4+t)^{(-5/2-n)}x^{n+1}}{2^{n+1}(n+1)!}, f\left(\dfrac{1}{2}\right) \sim 0.1048$

9 $x + \dfrac{x^3}{3}, 0.346$ **11** $x + \dfrac{x^3}{6}, 0.340$ **13** $x - \dfrac{x^2}{2}, 0.28$ **15** $x + \dfrac{x^3}{3}, 0.346$

17 $\dfrac{x^2}{2} - \dfrac{x^3}{6}, 0.049$

19 $e^x = e^2 + e^2(x-2) + \dfrac{e^2(x-2)^2}{2!} + \cdots + \dfrac{e^2(x-2)^n}{n!} + \dfrac{e^t(x-2)^{n+1}}{(n+1)!}$

21 $x^p = 1 + p(x-1) + \dfrac{p(p-1)(x-1)^2}{2} + \cdots + \dfrac{p(p-1)\cdots(p-n+1)(x-1)^n}{n!}$

$+ \dfrac{p(p-1)\cdots(p-n)t^{p-n-1}(x-1)^{n+1}}{(n+1)!}$

Section 9.11

1 96 **3** 6 **5** 1008 **7** $\sum_{n=0}^{\infty} x^n/(2^n n!), r = \infty$

9 $1 + x + \sum_{n=2}^{\infty} \dfrac{(-1)^{n+1}(1 \cdot 3 \cdot 5 \cdots (2n-3))x^n}{n!}, r = \dfrac{1}{2}$

11 $\sum_{n=0}^{\infty} \dfrac{(-1)^n x^n}{(2n)!}$, converges to $\cos\sqrt{x}$ for $x \geq 0$ **13** $\sum_{n=0}^{\infty} \dfrac{(-1)^n x^{2n}}{(2n+1)!}, r = \infty$

15 $1 - \dfrac{x^2}{2} + \sum_{n=2}^{\infty} -\dfrac{(1 \cdot 3 \cdot 5 \cdots (2n-3))x^{2n}}{2^n n!}, r = 1$ **17** $\sum_{n=0}^{\infty} \dfrac{(-1)^n x^{6n+4}}{(6n+4)(2n+1)!}, r = \infty$

19 $\sum_{n=0}^{\infty} \dfrac{x^{4n+1}}{(4n+1)(2n+1)!}, r = \infty$ **21** $x + \sum_{n=1}^{\infty} \dfrac{\frac{1}{3}(\frac{1}{3}-1)\cdots(\frac{1}{3}-n+1)x^{2n+1}}{n!(2n+1)}, r = 1$

23 $x + \sum_{n=1}^{\infty} \dfrac{1 \cdot 3 \cdots (2n-1)x^{2n+1}}{2^n n!(2n+1)^2}, r = 1$ **25** $\sum_{n=1}^{\infty} \dfrac{(-1)^{n+1}(x-1)^n}{n}, r = 1$

Extra Problems for Chapter 9

1 converges to 1 **3** converges to 1 **5** diverges to ∞ **7** diverges
9 converges to $28\frac{4}{15}$ **11** converges to 42 **13** diverges **15** diverges
17 converges **19** converges **21** diverges **23** converges **25** converges
27 converges **29** diverges **31** 1/2 **33** 1 **35** $\sqrt{e}$
37 $f'(x) = \sum_{n=1}^{\infty} n^{a+1}(n+1)^b 2^n x^{n-1}$, $\int_0^x f(t)\,dt = \sum_{n=1}^{\infty} n^a(n+1)^{b-1}2^n x^{n+1}$, $r = \frac{1}{2}$

39 $\sum_{n=0}^{\infty} \dfrac{(-1)^n x^{4n+1}}{(2n+1)(4n+1)}, r = 1$ **41** -0.006 **43** 0.646

45 $x + \sum_{n=1}^{\infty} \dfrac{2^n(-1)^n(2 \cdot 5 \cdot 8 \cdots (3n-1))x^{2n+1}}{3^n(2n+1)n!}, r = \dfrac{1}{\sqrt{2}}$ **47** e^{50}

Section 10.1

1 $\mathbf{i} + 2\mathbf{j}$ **3** $-3\mathbf{i} - 4\mathbf{j}$ **5** $(2, -4)$ **7** $(-1, 12)$ **9** $\mathbf{A} + \mathbf{B} = -3\mathbf{i} + \mathbf{j}$
11 $\mathbf{A} + \mathbf{B} + \mathbf{C} = \mathbf{j}$ **13** $3\mathbf{A} = 3\mathbf{i} - 6\mathbf{j}$ **15** $\mathbf{B} - \mathbf{A} = -5\mathbf{i} + 5\mathbf{j}$

17 $\mathbf{A} - 2\mathbf{B} + 3\mathbf{C} = 18\mathbf{i} - 8\mathbf{j}$ **19** $|\mathbf{B}| = 5$ **21** $|\mathbf{A} - \mathbf{B}| = 5\sqrt{2}$ **23** $|6\mathbf{A}| = 6\sqrt{5}$
25 $\frac{13}{4}\mathbf{i} - \frac{5}{4}\mathbf{j}$ **27** $-\frac{4}{5}\mathbf{i} + \frac{3}{5}\mathbf{j}, (-\frac{4}{5}, \frac{3}{5})$ **29** $\arccos(-(2\sqrt{5})/5)$ **31** $\arccos(-\frac{4}{5})$
33 $7\mathbf{i} + 3\mathbf{j}$ **35** $8\mathbf{i} - 2\mathbf{j}$ **37** $-4\mathbf{i} - 6\mathbf{j}$ **39** 5 **41** $4\mathbf{i} + 3\mathbf{j}$ **43** $10\mathbf{i} + 2\mathbf{j}$
45 $-2\sqrt{2}\mathbf{i} + 2\sqrt{2}\mathbf{j}$ **47** $6\mathbf{i} + 8\mathbf{j}$ **49** $2\mathbf{i} - \mathbf{j}, 2\mathbf{i} + 2\mathbf{j}, -5\mathbf{i} + 2\mathbf{j}, \mathbf{i} - 3\mathbf{j}$

Section 10.2

1 $\mathbf{X} = 3\mathbf{i} - \mathbf{j} + t(-\mathbf{i} + \mathbf{j})$ **3** $\mathbf{X} = 3\mathbf{i} + 4\mathbf{j} + t(-2\mathbf{i} + 5\mathbf{j})$ **5** $\mathbf{X} = \mathbf{i} + 4\mathbf{j} + t(\mathbf{i} - 5\mathbf{j})$
7 $\mathbf{X} = 2\mathbf{i} + 5\mathbf{j} + t\mathbf{j}$ **9** $\mathbf{X} = 2\mathbf{j} + t(\mathbf{i} + 5\mathbf{j})$ **11** $\mathbf{X} = 3\mathbf{j} + t\mathbf{i}$
13 $\mathbf{X} = 6\mathbf{i} + 5\mathbf{j} + t(\mathbf{i} - 3\mathbf{j})$ **15** $y = -2x + 10$ **17** $y = 3$ **19** no **21** yes
23 yes **25** $(-2, 3)$ **27** $(2, 10)$ **29** $(4, 3)$

Section 10.3

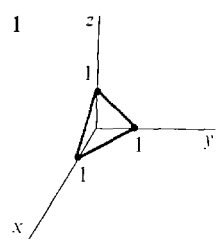
1 $5\mathbf{i} - \mathbf{j} + 7\mathbf{k}$ **3** $-\mathbf{k}$ **5** $(0, 0, 0)$ **7** $3\mathbf{i} + \mathbf{j} - 4\mathbf{k}$ **9** $\mathbf{i} + 5\mathbf{j} - 8\mathbf{k}$
11 $-2\mathbf{i} - 3\mathbf{j} + 6\mathbf{k}$ **13** 3 **15** $\sqrt{26}$ **17** $\arccos(\frac{8}{21})$ **19** 0
21 $\frac{1}{3}\mathbf{i} - \frac{2}{3}\mathbf{j} + \frac{2}{3}\mathbf{k}, (\frac{1}{3}, -\frac{2}{3}, \frac{2}{3})$ **23** $-3\mathbf{i} + 3\mathbf{j} + 3\sqrt{2}\mathbf{k}$ **25** $\frac{2}{3}, -\frac{2}{3}$ **27** $\frac{3}{10}\mathbf{i} - \frac{1}{2}\mathbf{j} + \frac{1}{10}\mathbf{k}$
29 $125\mathbf{i} + 250\mathbf{j} + 625\mathbf{k}$ **31** $\mathbf{X} = \mathbf{i} + 3\mathbf{j} + \mathbf{k} + t(\mathbf{i} - \mathbf{k})$
33 $\mathbf{X} = -\mathbf{i} + 4\mathbf{j} + 3\mathbf{k} + t(-\mathbf{i} - 7\mathbf{j} + 3\mathbf{k})$ **35** $\mathbf{X} = t(-3\mathbf{i} + 4\mathbf{k})$

Section 10.4

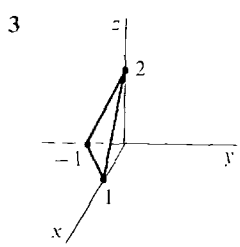
1 (a) 20 (b) $\mathbf{A} \parallel \mathbf{B}$ (c) 1 **3** (a) 0 (b) $\mathbf{A} \perp \mathbf{B}$ (c) 0
5 (a) 24 (b) neither (c) 12/37 **7** (a) -92 (b) neither (c) $-92/117$
9 (a) 0 (b) $\mathbf{A} \perp \mathbf{B}$ (c) 0 **11** (a) $8\sqrt{5}$ (b) $\mathbf{A} \parallel \mathbf{B}$ (c) 1 **13** 41
15 $3\mathbf{i} + 3\mathbf{j} + 3\mathbf{k}$ **17** $200\sqrt{2}$ **19** $\mathbf{i} - \mathbf{j}$ **21** $-2\mathbf{i} - 2\mathbf{j} - 4\mathbf{k}$ **23** $-\mathbf{i} + \mathbf{j} + \mathbf{k}$
23 $-\mathbf{i} - \mathbf{j} + \mathbf{k}$ **27** $\frac{4}{5}\mathbf{i} + \frac{3}{5}\mathbf{j}$ **29** $\mathbf{i} - \mathbf{j}$ **31** $\arccos(\frac{1}{3})$ **33** $\pi/3$

Section 10.5

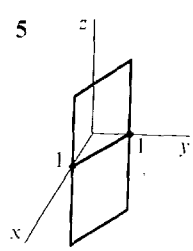
1



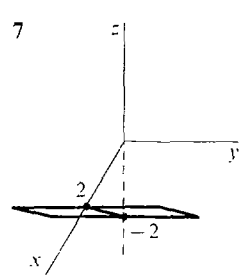
3



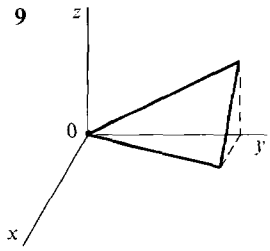
5



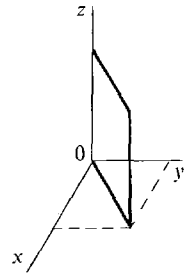
7



9



11



13 (a) $\mathbf{i} - 3\mathbf{j} + 6\mathbf{k}$ (b) $\mathbf{i} + 2\mathbf{j}$ (c) $-3\mathbf{i} + 4\mathbf{j} + \mathbf{k}$ (d) $\mathbf{i} + 6\mathbf{k}$ (e) $\mathbf{j}$ (f) $-\mathbf{j} + \mathbf{k}$
15 $y + 2z = -9$ **17** $x + y + 2z = 0$ **19** $y - z = -1$
21 $4x + 20y - 5z = 20$ **23** $x + 2y + z = 9$ **25** $2x + y + 3z = 13$
27 $x + y - 2z = 20$ **29** $x - y - 3z = 3$ **31** $24x - 19y + 4z = 57$ **33** parallel
35 neither **37** $\mathbf{X} = 5\mathbf{i} + 3\mathbf{j} - \mathbf{k} + t(\mathbf{i} - \mathbf{j} + 3\mathbf{k})$ **39** $\mathbf{X} = -\mathbf{i} + \mathbf{k} + t(3\mathbf{i} - \mathbf{j} - 2\mathbf{k})$
41 $\mathbf{X} = \mathbf{j} - \mathbf{k} + t(-\mathbf{i} + \mathbf{j} + \mathbf{k})$ **43** $(3, 1, 1)$ **45** $(-\frac{4}{3}, 0, \frac{8}{3})$ **47** $(-2, 1, 2)$
49 $(1, 1, 3)$

Section 10.6

1 $\mathbf{X} = 3t\mathbf{i} + 9t^2\mathbf{j}$ **3** $\mathbf{X} = \dfrac{1}{\sqrt{5}}t^3\mathbf{i} + \dfrac{2}{\sqrt{5}}t^3\mathbf{j}$ **5** $\mathbf{X} = (1/\sqrt{t^2 + 1})(t\mathbf{i} + \mathbf{j})$
7 $\mathbf{X} = \dfrac{\cos t + \cos(3t)}{2}\mathbf{i} + \dfrac{\sin t + \sin(3t)}{2}\mathbf{j}$
9 $\mathbf{X} = (4\cos(t/3) - \cos(4t/3))\mathbf{i} + (4\sin(t/3) - \sin(4t/3))\mathbf{j}$
11 $\mathbf{X} = (\cos t + t\sin t)\mathbf{i} + (\sin t - t\cos t)\mathbf{j}$ **13** $\mathbf{X} = \cos t\mathbf{i} + \sin t\mathbf{j} + t^2\mathbf{k}$
15 $\mathbf{X} = \mathbf{i} + \left(2 + \dfrac{t^2}{\sqrt{2t^4 - 2t^2 + 1}}\right)\mathbf{j} + \left(1 + \dfrac{t^2 - 1}{\sqrt{2t^4 - 2t^2 + 1}}\right)\mathbf{k}$
17 $\mathbf{X} = \frac{1}{2}(\cos t + \cos(2t))\mathbf{i} + \frac{1}{2}\sin t\mathbf{j} + \frac{1}{2}\sin(2t)\mathbf{k}$
19 $\mathbf{X} = (-\frac{5}{3} + \frac{2}{3}\cos t - \frac{1}{3}\sin t)\mathbf{i} + (-\frac{5}{3} - \frac{1}{3}\cos t + \frac{2}{3}\sin t)\mathbf{j} + (\frac{13}{3} - \frac{1}{3}\cos t - \frac{1}{3}\sin t)\mathbf{k}$
21 $\mathbf{X} = (t - t\cos^2 t - 2t\sin t\cos t)\mathbf{i} + (2t - t\sin t\cos t - 2t\sin^2 t)\mathbf{j} + 3t\mathbf{k}$
23 $\mathbf{P}(t) = 2t\mathbf{i} + \dfrac{1}{2t(t+1)}\mathbf{j} + (t + 1)\mathbf{k}$

Section 10.7

1 $5\cos t\mathbf{i} - 5\sin t\mathbf{j}$ **3** $-e^t\sin(e^t)\mathbf{i} + e^t\cos(e^t)\mathbf{j}$ **5** $-6\mathbf{i} + (6/t)\mathbf{j} - 6e^t\mathbf{k}$
7 $2\cos 2t$ **9** $t/\sqrt{1 + t^2}$ **11** $\mathbf{i} + \mathbf{j} + \mathbf{k} + t(\mathbf{i} + 2\mathbf{j} + 3\mathbf{k})$
13 $\mathbf{V} = 2\mathbf{i} + 3\mathbf{j} - 4\mathbf{k}, |\mathbf{V}| = \sqrt{29}, \mathbf{A} = \mathbf{0}$
15 $\mathbf{V} = -\sin t\mathbf{i} + \cos t\mathbf{j} + \mathbf{k}, |\mathbf{V}| = \sqrt{2}, \mathbf{A} = -\cos t\mathbf{i} - \sin t\mathbf{j}$
17 $\mathbf{V} = -e^t\sin(e^t)\mathbf{i} + e^t\cos(e^t)\mathbf{j}, |\mathbf{V}| = e^t,$
$\mathbf{A} = (-e^t\sin e^t - e^{2t}\cos e^t)\mathbf{i} + (e^t\cos e^t - e^{2t}\sin e^t)\mathbf{j}$
19 $\mathbf{V} = 2t\mathbf{i} + 4t\mathbf{j} - 2t\mathbf{k}, |\mathbf{V}| = 2\sqrt{6}|t|, \mathbf{A} = 2\mathbf{i} + 4\mathbf{j} - 2\mathbf{k}$
21 $\mathbf{S} = t\cos t\mathbf{i} + t\sin t\mathbf{j}, \mathbf{V} = (-t\sin t + \cos t)\mathbf{i} + (t\cos t + \sin t)\mathbf{j}, |\mathbf{V}| = \sqrt{1 + t^2},$
$\mathbf{A} = (-t\cos t - 2\sin t)\mathbf{i} + (-t\sin t + 2\cos t)\mathbf{j}$
23 $\mathbf{S} = \cos(t^2)\mathbf{i} + \sin(t^2)\mathbf{j}, \mathbf{V} = -2t\sin(t^2)\mathbf{i} + 2t\cos(t^2)\mathbf{j}, |\mathbf{V}| = |2t|,$
$\mathbf{A} = (-2\sin(t^2) - 4t^2\cos(t^2))\mathbf{i} + (2\cos(t^2) - 4t^2\sin(t^2))\mathbf{j}$
25 $\mathbf{V} = (e^x/\sqrt{1 + e^{2x}})\mathbf{i} + (e^{2x}/\sqrt{1 + e^{2x}})\mathbf{j}, |\mathbf{V}| = e^x,$
$\mathbf{A} = [-e^{3x}(1 + e^{2x})^{-3/2} + e^x(1 + e^{2x})^{-1/2}]\mathbf{i} + [-e^{4x}(1 + e^{2x})^{-3/2} + 2e^{2x}(1 + e^{2x})^{-1/2}]\mathbf{j}$
27 2π **29** 5 **31** $2\sqrt{3} + \sqrt{2}\ln(\sqrt{3} + \sqrt{2})$ **33** $\frac{3}{2} + \ln 2$
35 $\mathbf{F}(t) = (\frac{1}{2}t^2 + \frac{1}{2})\mathbf{i} + (\frac{1}{3}t^3 + \frac{5}{3})\mathbf{j} + (\frac{1}{4}t^4 + \frac{11}{4})\mathbf{k}$

37 $\mathbf{F}(t) = \ln|t-1|\mathbf{i} + (\ln|t-2| - \ln 2)\mathbf{j} + (\ln|t-3| - \ln 3)\mathbf{k}$
39 $\mathbf{S} = (t - \sin t)\mathbf{i} + (1 - \cos t)\mathbf{j} + \frac{1}{2}t^2\mathbf{k}$

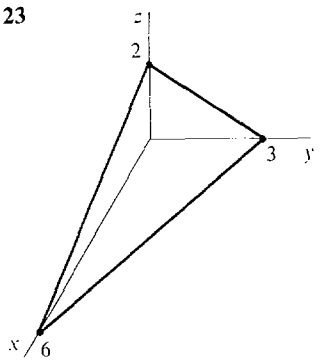
Section 10.8

1 infinitesimal **3** infinite **5** finite **7** infinite **9** infinite
11 infinitesimal (zero) **13** infinite **15** infinite **17** infinitesimal **19** infinite
21 $-\sin x\mathbf{i} + \cos x\mathbf{j}$ **23** $10\mathbf{i} - 20\mathbf{j} + 5\mathbf{k}$ **25** $2\mathbf{i} + 3\mathbf{j} - \mathbf{k}$ **27** 0
29 $(1/|\mathbf{A}|)\mathbf{A}\cdot\mathbf{U}$ if $\mathbf{A} \neq \mathbf{0}$, 1 if $\mathbf{A} = \mathbf{0}$ **31** (a) no (b) no **33** (a) yes (b) no
35 (a) yes (b) no **37** (a) no (b) no **39** (a) yes (b) no

Extra Problems for Chapter 10

1 $5\mathbf{i} - 12\mathbf{j}$ **3** $-3\mathbf{i} - 3\mathbf{j}$ **5** $9\mathbf{i} + 11\mathbf{j}$ **7** $\mathbf{X} = -\mathbf{i} + \mathbf{j} + t(4\mathbf{i} - 3\mathbf{j})$ **9** $(2, 5/2)$
11 $(1/\sqrt{105}, -10/\sqrt{105}, 2/\sqrt{105})$ **13** $100\mathbf{i} - 500\mathbf{j} + 300\mathbf{k}$
15 $\mathbf{X} = \mathbf{i} + 4\mathbf{j} + 3\mathbf{k} + t\mathbf{k}$ **17** $\mathbf{A} \perp \mathbf{B}$ **19** -20 **21** $-\mathbf{i} + 3\mathbf{j} - \mathbf{k}$

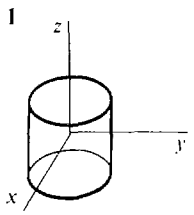
23



25 $-x - y + 2z = 0$ **27** $(-1, -2, 4)$
29 $\mathbf{S} = \sin t \cos t\mathbf{i} + \sin^2 t\mathbf{j} + \cos t\mathbf{k}$, $\mathbf{S} = -\sin t \cos t\mathbf{i} - \sin^2 t\mathbf{j} + \cos t\mathbf{k}$
31 $\mathbf{V} = \cos(2t)\mathbf{i} + \sin(2t)\mathbf{j} - \sin t\mathbf{k}$ or $\mathbf{V} = -\cos(2t)\mathbf{i} - \sin(2t)\mathbf{j} - \sin t\mathbf{k}$, $|\mathbf{V}| = \sqrt{1 + \sin^2 t}$,
$\mathbf{A} = -2\sin(2t)\mathbf{i} + 2\cos(2t)\mathbf{j} - \cos t\mathbf{k}$ or $\mathbf{A} = 2\sin(2t)\mathbf{i} - 2\cos(2t)\mathbf{j} - \cos t\mathbf{k}$
33 $\mathbf{i} + \frac{1}{2}\mathbf{j} + \frac{1}{3}\mathbf{k} + t(-\mathbf{i} - \frac{1}{4}\mathbf{j} - \frac{1}{9}\mathbf{k})$
35 $\mathbf{S} = (-\cos e^t + \cos 1)\mathbf{i} + (\sin e^t - \sin 1)\mathbf{j} + (e^t - 1)\mathbf{k}$

Section 11.1

1



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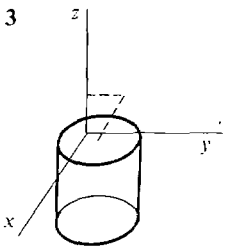

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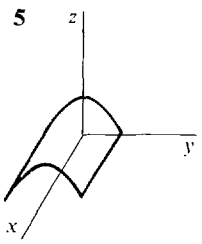

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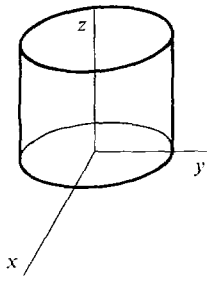

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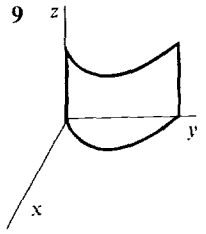

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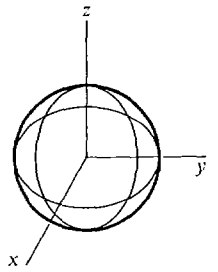

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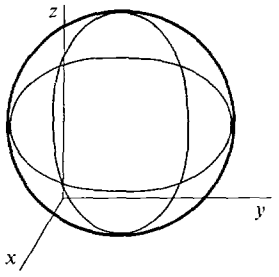

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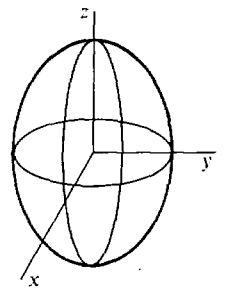

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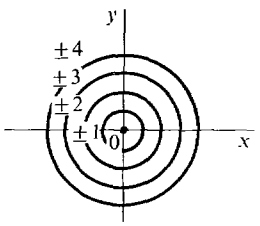

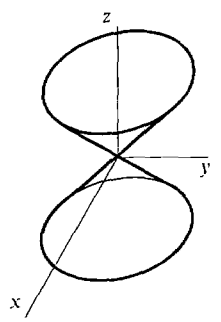

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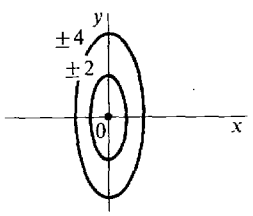

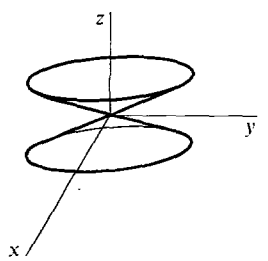

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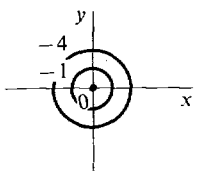

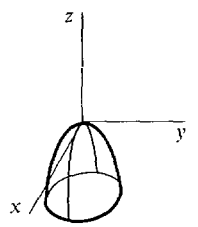

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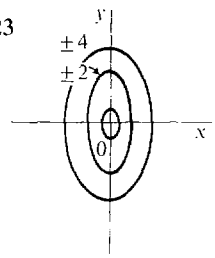

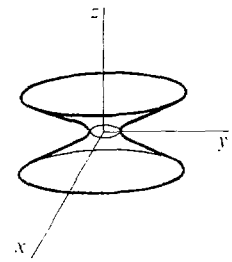

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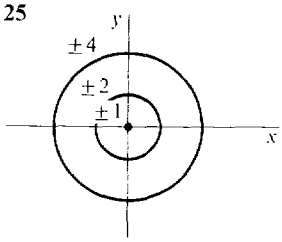

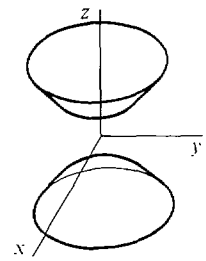

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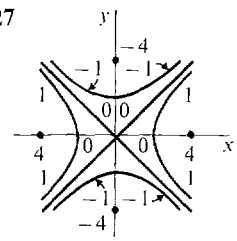

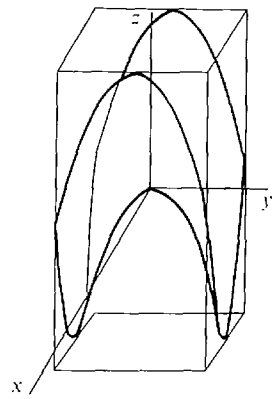

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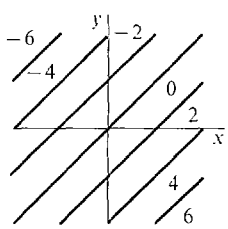

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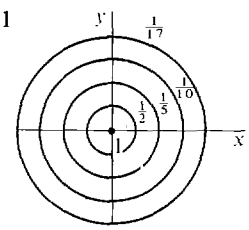

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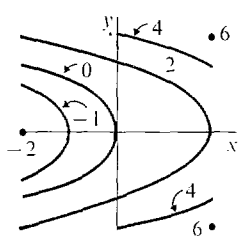

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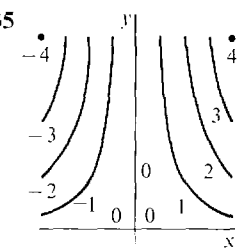

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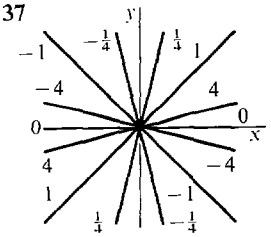

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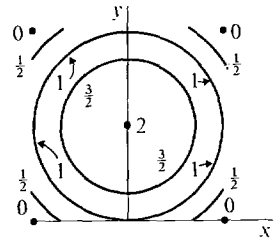

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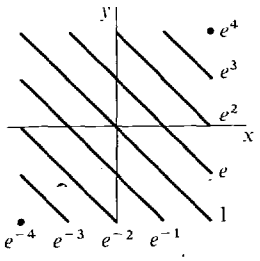

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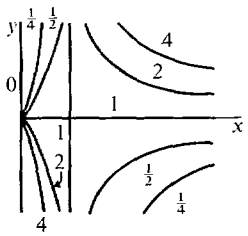


Section 11.2

1 all (x, y) **3** all (x, y) **5** $y \neq -x$ **7** $y \neq -2$ **9** $x \neq 2$ and $y \neq -1$
11 $x + y > 0$ **13** $x > y$ **15** $x > 0$ **17** $x^2 > y$ **19** $x > 0$ and $y > 0$
21 $x^2 > y$ **23** $x > 0$ and $y > 0$ and $x \neq 1/y$ **25** $x > 0$ and $y > 0$
27 $x \neq 4y$ and $y^2 > x$ **29** $\cos x + y > 0$ **31** $x \neq y$ **33** $x > y$ and $y \neq z$
35 $(x, y, z) \neq (0, 0, 0)$ **37** $x + y > 0$ and $z \neq 0$ **43** e **45** ∞

Section 11.3

1 $\partial z/\partial x = 4, \partial z/\partial y = -3$ **3** $\partial z/\partial x = y^2 + 3x^2y, \partial z/\partial y = 2xy + x^3$

5 $\dfrac{\partial z}{\partial x} = -\dfrac{2x}{(x^2 + y^2)^2}, \dfrac{\partial z}{\partial y} = -\dfrac{2y}{(x^2 + y^2)^2}$ **7** $f_x(x, y) = y, f_y(x, y) = x$

9 $f_x(x, y) = a, f_y(x, y) = b$ **11** $f_x(x, y) = 2xe^{x^2-y^2}, f_y(x, y) = -2ye^{x^2-y^2}$

13 $f_x(x, y) = \dfrac{1}{2\sqrt{x + 2y}}, f_y(x, y) = \dfrac{1}{\sqrt{x + 2y}}$ **15** $\partial z/\partial x = yx^{y-1}, \partial z/\partial y = x^y \ln x$

17 $\partial z/\partial x = 1/x, \partial z/\partial y = 1/y$

19 $\dfrac{\partial z}{\partial x} = -\dfrac{\ln y}{x(\ln x)^2}, \dfrac{\partial z}{\partial y} = \dfrac{1}{y \ln x}$ **21** $\dfrac{\partial z}{\partial x} = \dfrac{2xy}{\sqrt{1 - x^4y^2}}, \dfrac{\partial z}{\partial y} = \dfrac{x^2}{\sqrt{1 - x^4y^2}}$

23 $\dfrac{\partial w}{\partial x} = \dfrac{x}{\sqrt{x^2 + y^2 + z^2}}, \dfrac{\partial w}{\partial y} = \dfrac{y}{\sqrt{x^2 + y^2 + z^2}}, \dfrac{\partial w}{\partial z} = \dfrac{z}{\sqrt{x^2 + y^2 + z^2}}$

25 $f_x(x, y, z) = a, f_y(x, y, z) = b, f_z(x, y, z) = c$

27 $\partial w/\partial x = -z \sin x, \partial w/\partial y = z \cos y, \partial w/\partial z = \cos x + \sin y$ **29** $f_x(1, 2) = 4, f_y(1, 2) = 4$

31 $f_x(-1, 1) = -1, f_y(-1, 1) = 1$ **33** $\dfrac{\partial z}{\partial x}(0, 2) = 2, \dfrac{\partial z}{\partial y}(0, 2) = 0$

35 $\dfrac{\partial z}{\partial x}(1, 0) = e, \dfrac{\partial z}{\partial y}(1, 0) = 0$ **37** $\dfrac{\partial z}{\partial x}(2, 3) = -\dfrac{4}{961}, \dfrac{\partial z}{\partial y}(2, 3) = -\dfrac{27}{961}$

39 $f_x(1, 2, 3) = 2, f_y(1, 2, 3) = 4, f_z(1, 2, 3) = 6$ **41** $1/\sqrt{5}$ **43** $1/3$ **45** $b = 2, c = 1$

47 $C_x(x, y) = 3 - \frac{1}{2}\sqrt{y/x}, C_y(x, y) = 4 - \frac{1}{2}\sqrt{x/y}$

Section 11.4

1 $\Delta z = 3\,\Delta x - 2\,\Delta y, dz = 3\,dx - 2\,dy$

3 $\Delta z = 2xy^2\,\Delta x + 2x^2y\,\Delta y + y^2\,\Delta x^2 + 4xy\,\Delta x\,\Delta y + x^2\,\Delta y^2 + 2x\,\Delta x\,\Delta y^2 + 2y\,\Delta x^2\,\Delta y + \Delta x^2\,\Delta y^2, dz = 2xy^2\,dx + 2x^2y\,dy$

5 $\Delta z = -\dfrac{x\,\Delta y + y\,\Delta x + \Delta x\,\Delta y}{(x + \Delta x)(y + \Delta y)xy}, dz = -\dfrac{dx}{x^2y} - \dfrac{dy}{xy^2}$

7 $\Delta z = e^{3x-4y}(e^{3\,\Delta x - 4\,\Delta y} - 1), dz = e^{3x-4y}(3\,dx - 4\,dy)$

9 $\Delta z = \cos(x + \Delta x)\sin(y + \Delta y) - \cos x \sin y, dz = -\sin x \sin y\,dx + \cos x \cos y\,dy$

11 $\Delta z = x \ln(1 + (\Delta y/y)) + \Delta x \ln(y + \Delta y), dz = \ln y\,dx + (x/y)\,dy$

13 $\Delta w = \Delta x + 2\,\Delta y + 3\,\Delta z, dw = dx + 2\,dy + 3\,dz$

15 $\Delta w = y\,\Delta x + (x + z)\,\Delta y + y\,\Delta z + \Delta x\,\Delta y + \Delta y\,\Delta z, dw = y\,dx + (x + z)\,dy + y\,dz$

17 $\Delta z = dz + \Delta x\,\Delta x + \Delta y\,\Delta y$ **19** $\Delta z = dz + (y\,\Delta x + 2x\,\Delta y + \Delta x\,\Delta y)\Delta x + 0\,\Delta y$

21 $\Delta z = dz + \dfrac{\Delta y}{y(y + \Delta y)}\Delta x + \dfrac{x\,\Delta y}{y^2(y + \Delta y)}\Delta y$ **23** $z = 4x + 4y - 6$

25 $z = 4x + 4y - 2$ **27** $z = \frac{1}{2}x + \frac{1}{2}y + 1$ **29** $z = 6e^3x + e^3y - 8e^3$

31 $z = \dfrac{\sqrt{2}}{4}x + \dfrac{\sqrt{6}}{4}y + \dfrac{\sqrt{6}}{4} - \pi\left(\dfrac{\sqrt{2}}{12} + \dfrac{\sqrt{6}}{16}\right)$ **33** $z = x - 2$ **35** $z = 1$

37 $x - 2y + 2z = 9$ **39** $x + y - z = 1$

Section 11.5

1 $2e^{2t} + 2e^{-2t}$ **3** $-\dfrac{\cos(t/a) + \cos(t/b)}{[a \sin(t/a) + b \sin(t/b)]^2}$ **5** $\dfrac{2y}{x \ln y} - \dfrac{2x \ln x}{y(\ln y)^2}$

7 $(t + 1)^{1/t}\left[\dfrac{1}{t(t + 1)} - \dfrac{\ln(t + 1)}{t^2}\right]$ **9** $(\sin t)^{\cos t}\left[\dfrac{\cos^2 t}{\sin t} - \sin t \ln(\sin t)\right]$

11 $\dfrac{2t}{(t^2 - 1)\ln(t^2 + 1)} - \dfrac{2t \ln(t^2 - 1)}{(t^2 + 1)[\ln(t^2 + 1)]^2}$ **13** $3\sqrt{1 - t^4} - 2\sqrt{1 - t^3}$

15 $\dfrac{\partial z}{\partial s} = 3s^2 \cos^3 t, \dfrac{\partial z}{\partial t} = -3s^2 \sin t \cos^2 t$ **17** $\dfrac{\partial z}{\partial s} = \dfrac{2s}{s^2 - t^2}, \dfrac{\partial z}{\partial t} = -\dfrac{2t}{s^2 - t^2}$

19 $\dfrac{\partial z}{\partial s} = -\dfrac{a}{(s + t)^2} - \dfrac{b}{(s - t)^2}, \dfrac{\partial z}{\partial t} = -\dfrac{a}{(s + t)^2} + \dfrac{b}{(s - t)^2}$ **21** $b\dfrac{\partial z}{\partial x} = abf'(ax + by) = a\dfrac{\partial z}{\partial y}$

25 $\dfrac{dw}{dt} = e^t \cos(\sqrt{t}) - e^{-t} \sin(\sqrt{t}) + \dfrac{1}{2\sqrt{t}}(-e^t \sin(\sqrt{t}) + e^{-t} \cos(\sqrt{t}))$

27 $\dfrac{dz}{dt} = \dfrac{x(dx/dt) + y(dy/dt)}{\sqrt{x^2 + y^2}}$ or $\dfrac{dz}{dt} = \dfrac{x}{z}\dfrac{dx}{dt} + \dfrac{y}{z}\dfrac{dy}{dt}$

29 $\dfrac{dz}{dt} = x^y\left(\dfrac{y}{x}\dfrac{dx}{dt} + \ln x \dfrac{dy}{dt}\right)$ or $\dfrac{dz}{dt} = \dfrac{zy}{x}\dfrac{dx}{dt} + z \ln x \dfrac{dy}{dt}$

31 $\dfrac{\partial z}{\partial s} = af'(u), \dfrac{\partial z}{\partial t} = bf'(u)$ **33** $\dfrac{\partial z}{\partial s} = z\dfrac{\partial u}{\partial s}, \dfrac{\partial z}{\partial t} = z\dfrac{\partial u}{\partial t}$

35 $\dfrac{\partial z}{\partial s} = g'(s)h(t), \dfrac{\partial z}{\partial t} = g(s)h'(t)$ **37** -2 **39** -3 **41** 2 **43** $1/25$

Section 11.6

1 $\dfrac{\partial z}{\partial x} = 3, \dfrac{dz}{dx} = 3 - 4e^x$ **3** $\dfrac{\partial z}{\partial x} = -\sin x, \dfrac{dz}{dx} = -\sin x + 3\cos(3x)$

5 $\dfrac{\partial z}{\partial x} = yx^{y-1}, \dfrac{dz}{dx} = x^x(1 + \ln x)$ **7** $\dfrac{\partial z}{\partial x} = \dfrac{y}{1 + x^2y^2}, \dfrac{dz}{dx} = \dfrac{e^{-x}(1 - x)}{1 + x^2e^{-2x}}$ **9** $\dfrac{y + x}{y - x}$

11 $-\dfrac{2x + 2y^3}{6xy^2 + 1}$ **13** $-\dfrac{1 + y\cos(xy)}{x\cos(xy)}$ **15** slope $= -\frac{3}{4}, 4y = -3x + 14$

17 slope $= 5, y = 5x - 6$ **19** slope $= -1, y = -x + 2$ **21** slope $= 1, y = x$

23 $\dfrac{\partial w}{\partial x}(x, y) = 15, \dfrac{\partial w}{\partial y}(x, y) = -34$

25 $\dfrac{\partial w}{\partial x}(x, y) = \dfrac{10x - 6y}{\sqrt{10x^2 - 12xy + 5y^2}}, \dfrac{\partial w}{\partial y}(x, y) = \dfrac{-6x + 5y}{\sqrt{10x^2 - 12xy + 5y^2}}$

27 $6x - 5y + 4z = -21$ **29** $x + y + z = 3$ **31** $x + y + z = 0$

33 $\dfrac{\partial z}{\partial x} = -\dfrac{xy}{z}, \dfrac{\partial z}{\partial y} = -\dfrac{x^2}{2z}$ **35** $\dfrac{\partial z}{\partial x} = \dfrac{\cos(xy)}{\sin(yz)}, \dfrac{\partial z}{\partial y} = \dfrac{x\cos(xy) - z\sin(yz)}{y\sin(yz)}$

37 $\dfrac{\partial z}{\partial x} = -\dfrac{z}{3x}, \dfrac{\partial z}{\partial y} = -\dfrac{2z}{3y}$ **39** $\dfrac{dz}{dx} = y - \dfrac{x}{1 + \sqrt{x}}$

41 $\dfrac{dw}{dx} = \dfrac{\partial w}{\partial x} + \dfrac{\partial w}{\partial y}\dfrac{dy}{dx} + \dfrac{\partial w}{\partial z}\dfrac{dz}{dx}$

Section 11.7

1 max = 3 at $(-1, -1)$ and $(1, 1)$; min = 0 at $(0, 0)$

3 max = 48 at $(3, 3)$; min = -6 at $(1, -2)$ **5** max = 4 at $(2, 1)$; min = -5 at $(2, 4)$

7 max = 2 at $(\pi/2, \pi/2)$; min = 0 at $(0, 0)$, $(0, \pi)$, $(\pi, 0)$, (π, π)

9 max = 1 at $(-1, 1)$ and $(1, 1)$; min = $-\frac{1}{4}$ at $(0, \frac{1}{2})$

11 max = $\frac{1}{4}$ at $(\frac{1}{2}, 0, \frac{1}{2})$ and $(\frac{1}{2}, 1, -\frac{1}{2})$; min = $-\frac{1}{4}$ at $(0, \frac{1}{2}, \frac{1}{2})$ and $(1, \frac{1}{2}, -\frac{1}{2})$

13 max = $1 + \sqrt{2}$ at $(\sqrt{2}/2, \sqrt{2}/2, 1)$; min = $-\frac{1}{2}$ at $(-\frac{1}{2}, -\frac{1}{2}, \frac{1}{2})$

15 max = 3 at $(-1, -1, 1)$, $(-1, 1, 1)$, $(1, -1, 1)$, $(1, 1, 1)$; min = 0 at $(0, 0, 0)$

17 no max; min = -4 at $(-2, 0)$ **19** no max; no min

21 no max; min = 6 at $(\frac{1}{2}, 4)$ **23** max = 1 at $(0, 0)$; no min **25** no max, no min

27 $x = 4, y = 2, z = 2$ **29** 6 in. × 6 in. × 12 in. **31** $2\sqrt{3}/3$ **33** $(\frac{5}{3}, \frac{10}{3}, -\frac{5}{3})$

35 $(1, 1, 1)$, $(1, -1, -1)$, $(-1, 1, -1)$, $(-1, -1, 1)$

39 $\frac{2}{3}(\frac{9}{4}V)^{1/3}$ in. × $\frac{2}{3}(\frac{9}{4}V)^{1/3}$ in. × $(\frac{9}{4}V)^{1/3}$ in. **41** $x = 100, y = 200, P(100, 200) = 50{,}000$

Section 11.8

1 $\dfrac{\partial^2 z}{\partial x^2} = 2, \dfrac{\partial^2 z}{\partial y^2} = 4, \dfrac{\partial^2 z}{\partial x \partial y} = 0$ **3** $\dfrac{\partial^2 z}{\partial x^2} = 2a, \dfrac{\partial^2 z}{\partial y^2} = 2c, \dfrac{\partial^2 z}{\partial x \partial y} = b$

5 $\dfrac{\partial^2 z}{\partial x^2} = e^{x+y}(x + 2), \dfrac{\partial^2 z}{\partial y^2} = xe^{x+y}, \dfrac{\partial^2 z}{\partial x \partial y} = e^{x+y}(x + 1)$

7 $\dfrac{\partial^2 z}{\partial x^2} = -\dfrac{a^2}{(ax + by)^2}, \dfrac{\partial^2 z}{\partial y^2} = -\dfrac{b^2}{(ax + by)^2}, \dfrac{\partial^2 z}{\partial x \partial y} = -\dfrac{ab}{(ax + by)^2}$

9 $\dfrac{\partial^2 z}{\partial x^2} = a(a - 1)x^{a-2}y^b, \dfrac{\partial^2 z}{\partial y^2} = b(b - 1)x^a y^{b-2}, \dfrac{\partial^2 z}{\partial x \partial y} = abx^{a-1}y^{b-1}$

11 $\dfrac{\partial^2 w}{\partial x^2} = \dfrac{\partial^2 w}{\partial y^2} = \dfrac{\partial^2 w}{\partial z^2} = \dfrac{\partial^2 w}{\partial x \partial y} = \dfrac{\partial^2 w}{\partial x \partial z} = \dfrac{\partial^2 w}{\partial y \partial z} = -\dfrac{1}{4}(x + y + z)^{-3/2}$

13 $\dfrac{\partial^3 z}{\partial x^3} = 12y^3, \dfrac{\partial^3 z}{\partial y^3} = -36x^2, \dfrac{\partial^3 z}{\partial x^2 \partial y} = 24xy - 36y^2, \dfrac{\partial^3 z}{\partial x \partial y^2} = 12x^2 - 72xy$

15 $\dfrac{\partial^3 z}{\partial x^3} = a^3 e^{ax+by}, \dfrac{\partial^3 z}{\partial y^3} = b^3 e^{ax+by}, \dfrac{\partial^3 z}{\partial x^2 \partial y} = a^2 b e^{ax+by}, \dfrac{\partial^2 z}{\partial x \partial y^2} = ab^2 e^{ax+by}$

17 $\dfrac{\partial^2 z}{\partial \theta^2} = r^2 \sin^2\theta \dfrac{\partial^2 f}{\partial x^2} - 2r^2 \sin\theta \dfrac{\partial^2 f}{\partial x \partial y} + r^2 \cos^2\theta \dfrac{\partial^2 f}{\partial y^2} - r\cos\theta \dfrac{\partial f}{\partial x} - r\sin\theta \dfrac{\partial f}{\partial y}$

19 $\dfrac{\partial^2 z}{\partial x^2} = a^2 f''(u), \dfrac{\partial^2 z}{\partial y^2} = b^2 f''(u), \dfrac{\partial^2 z}{\partial x \partial y} = abf''(u)$ **21** $\dfrac{\partial^2 z}{\partial x^2} = g''(x), \dfrac{\partial^2 z}{\partial y^2} = h''(y), \dfrac{\partial^2 z}{\partial x \partial y} = 0$

23 $\dfrac{\partial^2 z}{\partial x^2} = n(n - 1)u^{n-2}\left(\dfrac{\partial u}{\partial x}\right)^2 + nu^{n-1}\dfrac{\partial^2 u}{\partial x^2}, \dfrac{\partial^2 z}{\partial y^2} = n(n - 1)u^{n-2}\left(\dfrac{\partial u}{\partial y}\right)^2 + nu^{n-1}\dfrac{\partial^2 u}{\partial y^2},$

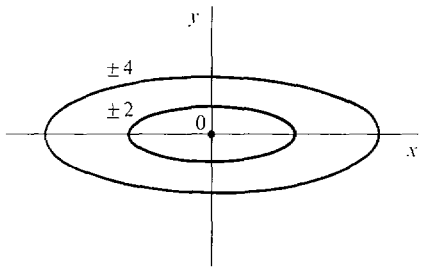
$\dfrac{\partial^2 z}{\partial x \partial y} = n(n - 1)u^{n-2}\left(\dfrac{\partial u}{\partial x}\right)\left(\dfrac{\partial u}{\partial y}\right) + nu^{n-1}\dfrac{\partial^2 u}{\partial x \partial y}$

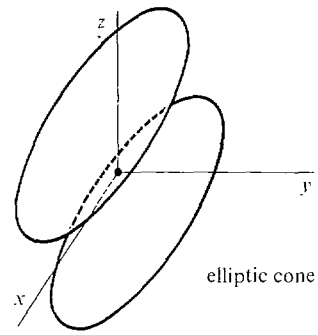
25 $\dfrac{\partial^2 z}{\partial s^2} = a\dfrac{\partial^2 x}{\partial s^2} + b\dfrac{\partial^2 y}{\partial s^2}, \dfrac{\partial^2 z}{\partial t^2} = a\dfrac{\partial^2 x}{\partial t^2} + b\dfrac{\partial^2 y}{\partial t^2}, \dfrac{\partial^2 z}{\partial s \partial t} = a\dfrac{\partial^2 x}{\partial s \partial t} + b\dfrac{\partial^2 y}{\partial s \partial t}$

27 $\dfrac{\partial^2 z}{\partial s^2} = f'(x)[(g'(s))^2 + g'(s)g''(s)], \dfrac{\partial^2 z}{\partial t^2} = f'(x)[(h'(t))^2 + h'(t)h''(t)], \dfrac{\partial^2 z}{\partial s \partial t} = f'(x)g'(s)h'(t)$

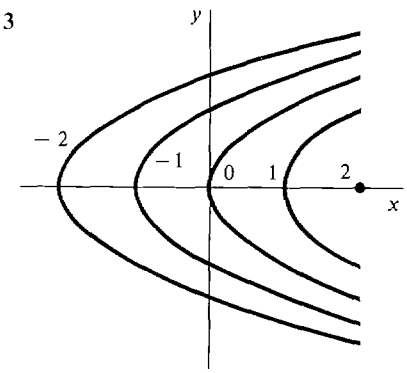
Extra Problems for Chapter 11

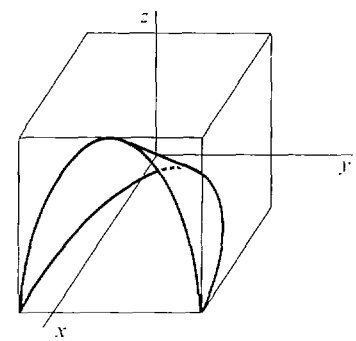
1





3





5 $x \neq 0$ **7** $1/x + 1/y > 0$ **9** $f_x(x, y) = a, f_y(x, y) = b$

11 $\dfrac{\partial z}{\partial x} = \dfrac{1}{x \ln y}, \dfrac{\partial z}{\partial y} = -\dfrac{\ln x}{y(\ln y)^2}$ **13** $\Delta z = -\dfrac{\Delta x}{x(x + \Delta x)} - \dfrac{2\,\Delta y}{y(y + \Delta y)}, dz = -\dfrac{dx}{x^2} - \dfrac{2\,dy}{y^2}$

15 $-8y + z = 4$ **17** $\dfrac{dz}{dt} = -\dfrac{2 \log_{(2t+1)}(3t + 2)}{(2t + 1) \ln (2t + 1)} + \dfrac{3}{(3t + 2) \ln (2t + 1)}$ **19** 1

21 $y = -8x + 17$, slope $= -8$ **23** max $= 4$ at $(0, 0)$ and $(3, 3)$; min $= -1$ at $(1, 2)$

25 no max; no min **27** $\dfrac{\partial^2 z}{\partial x^2} = -\dfrac{2xy^3}{(1 + x^2y^2)^2}, \dfrac{\partial^2 z}{\partial y^2} = -\dfrac{2x^3y}{(1 + x^2y^2)^2}, \dfrac{\partial^2 z}{\partial x \partial y} = -\dfrac{1 - x^2y^2}{(1 + x^2y^2)^2}$

29 $\dfrac{\partial^2 z}{\partial r^2} = \cosh^2 \theta \dfrac{\partial^2 f}{\partial x^2} + 2 \sinh \theta \cosh \theta \dfrac{\partial^2 f}{\partial x \partial y} + \sinh^2 \theta \dfrac{\partial^2 f}{\partial y^2}$

Section 12.1

1 $168/64 = 2.625$ **3** 44 **5** 1.025 **7** $(\pi/6)^2(7 + 4\sqrt{3}) \sim 3.8$
9 $e^{-5} + e^{-4} + 2e^{-3} + 2e^{-2} + 2e^{-1} + 2 + 2e + 2e^2 + e^3 + e^4 \sim 97.52$
11 $150/64 \sim 2.34$ **13** $((11 + 7\sqrt{2})\pi)/32 \sim 2.05$ **15** 108

Section 12.2

1 $7/2 = 3.5$ **3** $128/3 = 42\frac{2}{3}$ **5** $\frac{3}{2} \ln 2 \sim 1.04$ **7** 4
9 $\frac{1}{2}(e^6 - e^2 - e^{-2} + e^{-6}) \sim 197.9$ **11** $13/6 \sim 2.17$ **13** $32/15 \sim 2.13$
15 $36\pi \sim 113.1$ **17** 14/3 **19** 30 **21** 2 **23** $\frac{4}{15}(212 - 36\sqrt{6})$ **25** $e - 1$
27 8/3 **29** $3^8/40$
31 $0 \leq x \leq 5, 0 \leq y \leq 5 - x$, or $0 \leq y \leq 5, 0 \leq x \leq 5 - y$; $\int_0^5 \int_0^{5-x} f(x, y)\,dy\,dx$, or $\int_0^5 \int_0^{5-y} f(x, y)\,dx\,dy$

33 $-2 \le x \le 2, -\sqrt{4-x^2} \le y \le \sqrt{4-x^2}, \int_{-2}^{2}\int_{-\sqrt{4-x^2}}^{\sqrt{4-x^2}} f(x,y)\,dy\,dx$
35 $-4 \le x \le 1, 3x \le y \le 4 - x^2, \int_{-4}^{1}\int_{3x}^{4-x^2} f(x,y)\,dy\,dx$
37 $-1 \le y \le 1, 1/2 \le x \le 1/(1+y^2), \int_{-1}^{1}\int_{1/2}^{1/(1+y^2)} f(x,y)\,dx\,dy$ **39** $\pi/4$ **41** 32/3
43 $\frac{1}{2}\pi ab$

Section 12.3

1 3/4 **3** 1 **5** 4/3 **7** 16/15 **9** 8/3 **11** 8π **13** 8/15 **15** 144
17 $\frac{4}{3}\pi abc$

Section 12.4

1 (a) $4abk$ (b) $(0,0)$ (c) $\frac{4}{3}(ba^3 + ab^3)k$ **3** (a) $\frac{2}{3}k$ (b) $(\frac{3}{8}, \frac{3}{5})$ (c) $\frac{44}{105}k$
5 (a) 26/3 (b) (19/13, 151/65) (c) 944/15
7 (a) $\frac{2}{7} + \frac{1}{6}$ (b) $\left(\frac{\frac{2}{9}+\frac{2}{15}}{\frac{2}{7}+\frac{1}{6}}, \frac{\frac{1}{11}+\frac{1}{15}}{\frac{2}{7}+\frac{1}{6}}\right)$ (c) $\frac{2}{11} + \frac{1}{9} + \frac{2}{45} + \frac{1}{28}$
9 (a) $e^2 + e^{-2} - 2$ (b) $\left(\frac{e^2 + 3e^{-2} - 2}{e^2 + e^{-2} - 2}, \frac{e^4 + e^{-4} - 2}{4(e^2 + e^{-2} - 2)}\right)$
(c) $\frac{1}{9}e^6 + 2e^2 - \frac{2}{9} - 10e^{-2} + \frac{1}{9}e^{-6}$ **11** 2 **13** (a) $(\sqrt{2}/48)g$ (b) $g/24$
15 $m = \frac{8}{3}, W = \frac{16}{15}g$

Section 12.5

1 6π **3** 8π **5** $\frac{81}{2}\pi$ **7** $2\pi(1 - \ln 2)$ **9** 4/21 **11** $\pi/48$
13 32/9 **15** $8\pi^8 + \frac{64}{15}\pi^5$ **17** $5\pi/3$ **19** $\pi/3 - 4/9$ **21** $\frac{1}{3}(\beta - \alpha)(b^3 - a^3)$
23 (a) $\pi b^3/3$ (b) $\pi b^5/10$ **25** $(\pi k/2)(b^4 - a^4)$ **27** (a) $\bar{x} = 4/(3\pi), \bar{y} = 4/(3\pi)$ (b) $\pi k/8$
29 (a) $\bar{x} = 0, \bar{y} = \dfrac{3\sqrt{3} + 8\pi}{6\sqrt{3} + 4\pi}b$ (b) $\left(\frac{5}{6}\pi + \frac{7\sqrt{3}}{8}\right)b^4k$ **31** (a) π (c) $\sqrt{\pi}$

Section 12.6

1 12 **3** 12 **5** 13/56 **7** 16/27 **9** 40
11 $\frac{763}{594} \times 10^9 = (\frac{4}{27} + \frac{100}{88}) \times 10^9 \sim 1.3 \times 10^9$
13 $\dfrac{e^6}{24} - \dfrac{e^4}{15} + \dfrac{e^{-2}}{24} - \dfrac{e^{-6}}{60}$ **15** $\dfrac{52}{63} - \dfrac{12\sqrt{3}}{35}$
17 (a) 3 (b) $(\frac{19}{36}, \frac{5}{9}, \frac{7}{12})$ (c) $I_z = \frac{9}{4}, I_y = \frac{7}{3}, I_x = \frac{29}{12}$
19 (a) 1 (b) $(\frac{3}{4}, \frac{5}{12}, \frac{7}{12})$ (c) $I_z = \frac{5}{6}, I_y = \frac{11}{10}, I_x = \frac{11}{15}$
21 (a) $\frac{5}{18}$ (b) $(\frac{3}{20}, \frac{3}{20}, \frac{65}{972})$ (c) $I_z = \frac{5}{16}, I_y = \frac{73}{960}, I_x = \frac{73}{960}$
23 (a) $\frac{1}{6}abck$ (b) $\left(\frac{a}{4}, \frac{b}{4}, \frac{c}{4}\right)$ (c) $I_z = \dfrac{abck}{60}(a^2 + b^2), I_y = \dfrac{abck}{60}(a^2 + c^2), I_x = \dfrac{abck}{60}(b^2 + c^2)$
25 (a) $abck$ (b) $\left(\frac{a}{2}, \frac{b}{2}, \frac{c}{2}\right)$ (c) $I_z = \dfrac{abck}{3}(a^2 + b^2), I_y = \dfrac{abck}{3}(a^2 + c^2), I_x = \dfrac{abck}{3}(b^2 + c^2)$

Section 12.7

1 $\dfrac{4\pi}{3}$ **3** $\dfrac{\pi}{10}$ **5** $\dfrac{128}{7}$ **7** $\dfrac{2\pi hb^3}{3}$ **9** $\dfrac{\pi hb^4}{10}$ **11** $\left(0, 0, \dfrac{2}{3}\right)$
13 $\dfrac{b^4ck\pi}{2} + \dfrac{2b^2c^3k\pi}{3}$ **15** $\dfrac{\pi hb^4k}{10}$ **17** $\dfrac{4\pi b^5}{5}$ **19** $\dfrac{4\pi}{15}$ **21** $\dfrac{4\pi b^4}{3}$
23 $\dfrac{\pi b^5}{10}(1 - \cos(2\alpha))$ or $\dfrac{\pi b^5}{5}\sin^2\alpha$ **25** $\frac{4}{3}\pi(b^3 - a^3)$ **27** $\dfrac{\pi b^3}{6}(1 - \cos^4\beta)$ **29** πc^4
31 $\dfrac{8\pi kb^5}{15}$ **33** $b^3\left(\dfrac{2\pi}{3} - \dfrac{8}{9}\right)$ **35** $\frac{3}{8}b$ from the center

Extra Problems for Chapter 12

1 0 **3** 0 **5** 1/3 **7** 4/5 **9** $\frac{1}{2}(\ln 2)^2 - \frac{1}{6}(\ln 2)^3$ **11** 1/6
13 $m = 2k, (\bar{x}, \bar{y}) = (\pi/2, \pi/8), I_0 = (\pi^2 - \frac{32}{9})k$ **15** $m = \pi r^4/4, (\bar{x}, \bar{y}) = (0, 0), I_0 = \pi r^6/6$
17 45π **19** $2\pi a$ **23** 311/3960
25 $(\bar{x}, \bar{y}, \bar{z}) = (\frac{1}{5}, \frac{1}{5}, \frac{1}{30}), I_z = \dfrac{k}{60}, I_y = I_x = \dfrac{29k}{3360}$
27 $(\bar{x}, \bar{y}, \bar{z}) = \left(0, 0, \dfrac{b^2 + c}{2}\right), I_z = \dfrac{\pi b^4 ck}{2}$ **29** $m = \pi(b^4 - a^4), I = \dfrac{4\pi}{9}(b^6 - a^6)$

Section 13.1

1 $\mathbf{grad} f = 2x\mathbf{i} + 2y\mathbf{j}, f_U = \sqrt{2}x + \sqrt{2}y$ **3** $\mathbf{grad} f = 2xy^3\mathbf{i} + 3x^2y^2\mathbf{j}, f_U = \frac{6}{5}xy^3 - \frac{12}{5}x^2y^2$
5 $\mathbf{grad} f = -\sin x \sin y\mathbf{i} + \cos x \cos y\mathbf{j}, f_U = (1/\sqrt{5})(-\sin x \sin y + 2\cos x \cos y)$
7 $\mathbf{grad} f = \dfrac{x}{\sqrt{x^2 + y^2}}\mathbf{i} + \dfrac{y}{\sqrt{x^2 + y^2}}\mathbf{j}, f_U = \dfrac{x - y}{\sqrt{2x^2 + 2y^2}}$
9 $\mathbf{grad} f = yz\mathbf{i} + xz\mathbf{j} + xy\mathbf{k}, f_U = \frac{1}{3}(yz + 2xz - 2xy)$
11 $\mathbf{grad} f = -x^{-2}\mathbf{i} - 2y^{-2}\mathbf{j} - 3z^{-2}\mathbf{k}, f_U = (1/\sqrt{2})(-x^{-2} + 3z^{-2})$
13 $\mathbf{grad} f = \dfrac{x\mathbf{i} + y\mathbf{j} + z\mathbf{k}}{\sqrt{x^2 + y^2 + z^2}}, f_U = \dfrac{x\cos\alpha + y\cos\beta + z\cos\gamma}{\sqrt{x^2 + y^2 + z^2}}$ **15** $7\sqrt{10}/20$
17 $9a/\sqrt{a^2 + b^2}$ **19** $-1/\sqrt{3}$ **21** $(1/\sqrt{2})(\mathbf{i} + \mathbf{j})$ **23** $\frac{1}{7}(3\mathbf{i} + 6\mathbf{j} + 2\mathbf{k})$
25 $(f_U)_V = \dfrac{\partial^2 z}{\partial x^2}u_1v_1 + \dfrac{\partial^2 z}{\partial x \partial y}(u_1v_2 + u_2v_1) + \dfrac{\partial^2 z}{\partial y^2}u_2v_2$

Section 13.2

1 $2e^3$ **3** $\frac{9}{2}e - \frac{3}{2}$ **5** $\sin 1 - \cos 1 + 1$ **7** $\frac{3}{20} + \frac{5}{7}\ln 4$ **9** $-2\pi, 2\pi$
11 -4π **13** $\frac{11}{30}$ **15** $\frac{1}{2}$ **17** $\frac{1}{2}\ln(\frac{29}{2})$ **19** 1243/3

Section 13.3

1 no potential function **3** no potential function **5** no potential function
7 $y\sin x + C$ **9** $-2x + 6y + C$ **11** no potential function
13 $\frac{3}{2}x^2 + 5xy - y^2 + C$ **15** $\cosh x \cosh y + C$ **23** $\frac{3}{2}x^2 + 4xy - y^2 = C$
25 $\frac{2}{3}x^{3/2} + x\sqrt{y} = C$ **27** $\frac{1}{3}y^3 + y\arctan x = C$ **29** $\cos x \sin y = C$
31 $(x^2/2) + (y^2/2) + (2/3)(x + y)^{3/2} = C$ **33** $P(x, y) = 2\sin x \cos x \sin y$

Section 13.4

1 1 **3** $\frac{1}{2}(-e^7 + e^{-1} + e - e^{-7})$ **5** $-\frac{1}{6}$ **7** $\frac{11}{2} - \ln 2$ **9** $-17/12$
11 $-\pi/2$ **13** (a) $-x - y$ (b) -1 (c) $y - x$ (d) 0
15 (a) $2bx - 2ay$ (b) $(2b - a)/3$ (c) 0 (d) 0 **17** (a) -2 (b) -2π (c) 0 (d) 0
19 $\pi a^2 + \pi/2$

Section 13.5

1 $25\sqrt{21}/4$ **3** $(\pi/6)(5\sqrt{5} - 1)$ **5** $\pi a^2/2$ **7** $(\pi/6)[(1 + 4a^2)^{3/2} - 1]$
9 $a^2(\pi - 2)$ **11** $A\sqrt{1 + a^2 + b^2}$ **13** $8a^2$ **15** 16 **17** $-\pi$ **19** $-2e^{-1}$

Section 13.6

1 $\mathbf{curl}\,\mathbf{F} = \mathbf{0}$, $\mathrm{div}\,\mathbf{F} = 2x + 2y + 2z$ **3** $\mathbf{curl}\,\mathbf{F} = -\mathbf{i} + \mathbf{j} - \mathbf{k}$, $\mathrm{div}\,\mathbf{F} = 3$
5 $\mathbf{curl}\,\mathbf{F} = (ze^{x+y} - ye^{x+z})\mathbf{i} + (xe^{y+z} - ze^{x+y})\mathbf{j} + (ye^{x+z} - xe^{y+z})\mathbf{k}$,
$\mathrm{div}\,\mathbf{F} = e^{y+z} + e^{x+z} + e^{x+y}$ **9** 0 **11** $A(p(c - b) + q(a - c) + (a - b))$
13 $abc(a + b + c)$ **15** 3 **17** $\pi/3$ **19** $\pi/2$

Extra Problems for Chapter 13

1 $-\sin x \cos \alpha + \cos y \sin \alpha$ **3** $\mathbf{grad} f = ye^{xy}\mathbf{i} + xe^{xy}\mathbf{j}$, $f_U = e^{xy}(y \cos \alpha + x \sin \alpha)$
5 $\frac{1}{\sqrt{14}}(-2\mathbf{i} - 3\mathbf{j} + \mathbf{k})$ **7** $\ln\left(\frac{6\sqrt{2}}{5}\right)$ **9** 0 **11** $x \ln x + xy \ln y - x$
13 $\frac{3}{2}y^2 - e^{-y}\cos x = C$ **15** $\frac{131}{60}$ **17** $\frac{\sqrt{6}}{2} - \frac{\sqrt{2}}{6}$ **19** 2π
21 $\mathbf{curl}\,\mathbf{F} = (x^2z - 3xy^2z^2)\mathbf{i} + (xy - 2xyz)\mathbf{j} + (y^2z^3 - xz)\mathbf{k}$, $\operatorname{div}\mathbf{F} = yz + 2xyz^3 + x^2y$

Section 14.1

1 $y = -1/2 \cos(t^2) + C$ **3** $y = \ln(t + C)$ **5** $y = \frac{1 + Ce^{2t}}{1 - Ce^{2t}}$, $y = 1$, $y = -1$
7 $y = -\frac{1}{0.5t^2 + C}$, $y = 0$ **9** $y = \tan(e^t + C)$ **11** $y = C \sec t$, $y = 0$
13 $y = \left(\frac{t^2}{4} + 9\right)^{1/2}$ **15** $y = -\sqrt{2(t \ln t - t) + 6}$ **17** $y = 2$

Section 14.2

1 $y = C \cdot e^{-5t}$ **3** $y = C \cdot e^{\arctan t}$ **5** $y = 4 \cdot e^{-t}$ **7** $y = e \cdot e^{\cos t}$ **9** $y = 0$
11 $y = 4t^2$ **13** $y = e^{1-t^{-2}}$ **15** $y = 100 \cdot e^{-t \cdot \ln 5}$ **17** $y = 1{,}000{,}000 \cdot e^{t \cdot \ln 1.5}$

Section 14.3

1 $y = 2 + Ce^{-4t}$ **3** $y = 5 + Ce^{-(1/2)t^2}$ **5** $y = -(t^2 + 2t + 2) \cdot Ce^{-4t}$
7 $y = \frac{1}{3}t^{-1} + Ct^2$ **9** $y = \sin t + C \cos t$ **11** $y = e^{-\cos t}\left(\int_0^t se^{\cos s}\,ds + C\right)$
13 $y = e^{-\int_0^t \cos(e^r)\,dr}\left[\int_0^t e^{\int_0^s \cos(e^r)\,dr}\,ds + C\right]$
15 $-[400{,}000t + 15{,}840{,}000] + 15{,}940{,}000e^{0.025t}$
17 $15{,}000e - 25{,}000$ dollars, or \$15,774.23

Section 14.4

	t	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1	$Y(t)$	1.0	1.0	1.01	1.030	1.059	1.097	1.142	1.195	1.253	1.317	1.386
3	$Y(t)$	1.0	1.054	1.095	1.122	1.137	1.140	1.133	1.117	1.093	1.061	1.023

5 Apply the lemma with $M = 4$. **7** Apply the lemma with $M = \pi/2$.
9 $y(t) = 0$ for $0 \le t \le b$, $y(t) = [(2/3)(t - b)]^{3/2}$ for $b < t < \infty$.

Section 14.5

1 $10 - i2$ **3** $i10$ **5** $0.1 - i(0.7)$ **7** 4 **9** $\pm i5$ **11** $-1 \pm i2$
13 $5\,cis(\pi/2)$ **15** $3\sqrt{2}\,cis(-3\pi/4)$ **17** $2\,cis(-\pi/6)$ **19** $-i2/3$
21 $2\,cis(-\pi/12)$ **23** $-4 + i4$ **25** $\pm 2^{1/4}\,cis(\pi/8)$ **27** $\pm 2\,cis(-\pi/4)$, or $\pm\sqrt{2}(1 - i)$ **29** ie^{-3} **31** $e\sqrt{2}/2 - ie\sqrt{2}/2$ **33** $(5 - i3)e^{(5-i3)t}$
35 $(3 + i2)e^{(2-i7)+(3+i2)t}$ **37** $Ce^{(-2+i3)t}$ **39** $Ce^{(3-i5)t}$
41 $e^{i+(2-i)t}$, or $e^{2t}\,cis(1 - t)$ **43** $4e^{(2-i)t}$, or $4e^{2t}\,cis(-t)$

Section 14.6

1 $Ae^{2t} + Be^{-3t}$ **3** $Ae^{5t} + Bte^{5t}$ **5** $A\cos(4t) + B\sin(4t)$
7 $e^{t}[A\cos t + B\sin t]$ **9** $-\frac{1}{4}e^{-5t} + \frac{5}{4}e^{-t}$ **11** $5e^{-6t} + 20te^{-6t}$
13 $-2\cos(\sqrt{5}t) + \sqrt{5}\sin(\sqrt{5}t)$ **15** $e^{-6t}[4\cos t + 24\sin t]$
17 $2\cos(2t - \pi/6)$, amplitude $= 2$, frequency $= 2$, phase shift $= \pi/6$
19 $e^{-2t}\sqrt{2}\cos(3t - \pi/4)$, amplitude $= \sqrt{2}e^{-2t}$, frequency $= 3$, phase shift $= \pi/4$
21 $e^{-2t}[2\cos(5t) + \sin(5t)]$

Section 14.7

1 $(24/676)\cos t - (10/676)\sin t$ **3** $(1/2)t^2 + (3/16)t - (3/8)$ **5** $0.5e^{2t}$
7 $-0.2te^{-3t}$ **9** $0.125t\sin(4t)$ **11** $3t^2e^{-6t}$ **13** $Ae^{-3t} + Be^{-2t} + 0.8$
15 $A\cos(\sqrt{5}t) + B\sin(\sqrt{5}t) + 2\sin(2t)$ **17** $4e^{t} + e^{-t} - 3t - 5$
19 $e^{-6t}[2\cos t + 20\sin t] + 2e^{-4t}$
21 $e^{-2t}[A\cos(5t) + B\sin(5t)] + 25\cos(2t) + 8\sin(2t)$, steady state $= 25\cos(2t) + 8\sin(2t)$
25 5

Extra Problems for Chapter 14

1 $y = -1/(\sin t + C)$ **3** $y = -\ln(-\ln|t| + e^{-2})$ **5** $y = Ce^{-5t^2}$ **7** $y = e^{-6t}$
9 $y = (2/3)t - 2/9 + Ce^{-3t}$ **11** $y = 3{,}500{,}000e^{0.02t} - 2{,}500{,}000$
15 $y = Ae^{4t} + Be^{t}$ **17** $y = e^{2t}[A\cos(2t) + B\sin(2t)]$ **19** $y = -(1/6)e^{-5t} + (1/6)e^{t}$
21 $y = e^{-(3/2)t}[10\cos(t/2) + 30\sin(t/2)]$ **23** $y = Ae^{4t} + Be^{t} + 13/16 + t/4$
25 $y = -2\cos t - 3\sin t - (1/6)e^{-5t} + (13/6)e^{t}$

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