ERRATA for *Calculus: The Language of Change*

SECTION 1.2 Integrals

EXERCISES

P.8 Exercise 9d: change to $B'(11)$
P.9 Exercise 22d: change "*proportional*" to "*equal.*"

ANSWERS

P877 Exercise 5a $\int_{-1}^{0.75} E'(t) < \int_{0}^{0.25} E'(t)$
P877 Exercise 9d $B'(11) = 0$ inches/hour
P878 Exercise 23i $A''(t) = g - k(A'(t))^2; \quad k > 0$

SECTION 1.3 Quantity and Change

APPLICATIONS

P12 Application 8a Change "*holds*" to "*can hold*"

SECTION 2.3 Graphing f from f'

TEXT

P36 Second EXAMPLE on page. Change the second sentence in the solution to the following:
Let's say her top speed z' is 10 feet per second and that her speed increases constantly from the start until she reaches this top speed in 10 seconds.

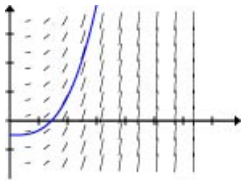
P40 Exercises 11-18 There should be no heavy dots on the vertical axes.

EXERCISES

P41 Exercise 20 The third line down from the top in the second column on P 41: change "*inches per hour*" to "*feet per hour.*" Also, the label for the vertical axis in the picture should be "Feet per hour."

ANSWERS

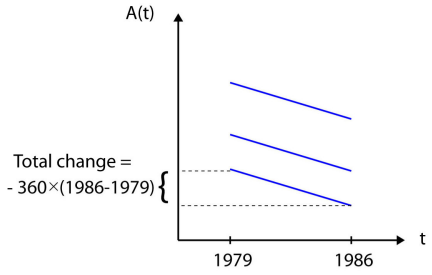
P885 Exercise 17 Correct picture should be



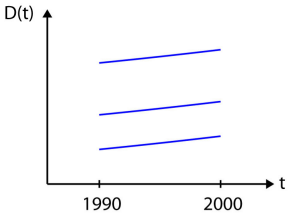
SECTION 2.4 Differential Equations

ANSWERS

P887 Exercise 27b Picture should be



P887 Exercise 29b Picture should be



P887 Exercise 31a delete the notation (dt). The answer should be $\int_{1993}^{1999} S' = -23,491$.

SECTION 4.3 The Product Rule

EXERCISES

P153 Exercise 44 Line 5 Change "*per person per year*" to "*per million persons per year.*"

SECTION 3.1 The Derivative at a Point

EXERCISES

P71 Exercises 7 and 8 There should be a space between the expression for the function and the comma that follows it. Students have been known to see that comma as a prime on the t in the denominator.

SECTION 4.5 The Chain Rule

EXERCISES

P167 Exercise 26b should read: Estimate $f'(g(-1)), f'(g(3)), g'(-1),$ and $g'(3)$
Exercise 27b should read: Estimate $f'(g(-1)), f'(g(1)), g'(-1),$ and $g'(1)$
Exercise 28b should read: Estimate $f'(g(-1)), f'(g(2)), g'(-1),$ and $g'(2)$
Exercise 29b should read: Estimate $f'(g(-2)), f'(g(1)), g'(-2),$ and $g'(1)$

P168 Exercise 34 line 3 after "*labor*" insert: "*, and* $a, r,$ *and* q *are constants.*"

P168 Exercise 35 line 3 should be: "*by* $x(t) = -3\sqrt{t} + 3$ *inches. What is the rate at*"

ANSWERS

P906 Exercise 35 The answer should be $-\frac{9}{2\sqrt{t}}(-3\sqrt{t} + 3)^2$

SECTION 4.6 Differentiating Complicated Functions

TEXT

P170 Second Example on the page: First line in step B should be:
$(y^3 \sin(y-7))' = (y^3)' \sin(y-7) + y^3(\sin(y-7))'$.

P175 Line 6 from bottom: The reference should be to Section 3.6.

SECTION 4.7 Integrating Elementary Functions

TEXT

P175 Part 2 in the statement of the Fundamental Theorem of Calculus near the bottom of the page should be $\int_a^b g(x)dx = f(b) - f(a)$. (The dx is missing in the text.)

P177 EXAMPLE Line 3 from bottom in the Example: Change "*theorems*" to "*functions*"

P178 The paragraph under Notation 4.20 should begin "*One distinction...*"

ANSWERS

P908 Exercise 7 Answer should be $-\frac{1}{7}\cos(q) + C$.

P908 Exercise 25 The answer should be: "*The area is 2.*"

SECTION 4.9 Exponential Growth and Decay

TEXT

P189 The function at the bottom of the page should be $g(x) = \frac{2^{x+0.001} - 2^x}{0.001}$

EXERCISES

P194 Exercise 25 should read: $p(x) = e^{\sqrt{x}}$

ANSWERS

P909 Answer to Exercise 25 is $p'(x) = \frac{e^{\sqrt{x}}}{2\sqrt{x}}$

SECTION 4.10 The Natural Logarithm

TEXT

P196 The second equation in the tan-shaded box in the middle of the page should be $(\ln(x))' = \frac{1}{x}$.

P197 The last formula in the left column in the box at the top of the page should be $(\ln(x))' = \frac{1}{x}$.

EXERCISES

P202 Exercise 66a should read: A rock is thrown upward from the roof of a building. Translate "the velocity of the rock decreases at the rate of 32 feet per second per second" into an equation. Exercise 66b should read: Given that the rock is moving at a speed of 20 ft/sec at $t = 2$, find exactly the velocity of the rock at $t = 5$.

SECTION 4.11 The Shroud of Turin

TEXT

P203 The first formula on the page should be $(C_{14})' = -kC_{14}$.
P203 Laboratory, fact 3, the first equation should be $(C_{14})' = -kC_{14}$.

SECTION 5.1 Sequences

ANSWERS

P912 Answer to Exercise 9 should be "False." (The rest of that answer is correct as printed.)

SECTION 5.2 The Derivative

EXERCISES 5.2

P252 Exercise 94 Proposition 5.11 should end with "*then* $\lim_{x\to\infty}(f(x) + g(x)) = L + M$."

SECTION 5.5 The Integral

TEXT

P271 Proposition 5.2 The Proposition should end with the sentence: "*Then g is integrable on* $[a, c]$ *and* $\int_a^b g(t)dt \quad + \int_b^c g(t)dt = \int_a^c g(t)dt$."

P273 Definition 5.21 should read: "*for all real numbers a and all functions g,* $\int_a^a g(t)dt = 0$."
P273 Definition 5.22 should read: "*For all* $a < b$ *and all functions g integrable on* $[a, b]$, $\int_a^b g(t)dt = -\int_b^a g(t)dt$."

EXERCISES

P274 Exercise 21 The Exercise should read: "Is f integrable on the interval $[1, 2)$, which includes 1 but not 2?"

P274 Exercise 22 The Exercise should read: "Is f integrable on the interval $[2, 3)$, which includes 2 but not 3?"

P274 Exercise 23 The interval should be $[1, 3)$.

P274 Exercise 24 The Exercise should read: "Intuitively, what would you say is the area below f over the interval $[1, 2]$?"

ANSWERS

P917 Exercise 21 The interval should be $[1, 2)$.

P917 Exercise 23 The answer should read: "No. If g were an antiderivative for f on $[1, 3)$, then for $x < 2, g'(x) = 1$ and for $x > 2, g'(x) = 2$. Thus, g would not be differentiable at $x = 2$."

P917 Exercise 25 The answer should read: "*A reasonable guess for the answer to Exercise 24 is 1. You can get a lower sum for the integral representing the area as follows: Let* $d_0 = 1, d_1 = 1.25, d_2 = 1.5, d_3 = 1.99, d_4 = 2$, *and let* $c_1 = 0.95, c_2 = 0.95, c_3 = 0.95, c_4 = 2$. *Then the associated lower sum is* $0.95 \times 0.99 + 0.01 \times 2 = 0.9605$, *which differs from* 1 *by less than* 0.1."

P917 Exercise 27 For each l_n, let $d_0 = 1$, $d_1 = 2$, and $c_1 = 1$. Then $l_n = 1$ and $\boldsymbol{l} \to 1$. For each u_n, let $d_i = 1 + \frac{i}{n}$ for $0 \leq i \leq n$, let $c_i = 1$ for $1 \leq i < n$, and let $c_n = 2$. Then $u_n = 1 \cdot \frac{n-1}{n} + 2 \cdot \frac{1}{n} = 1 + \frac{1}{n}$ and $\boldsymbol{u} \to 1$. Thus, by definition 5.18, $\int_1^2 g(x) = 1$.

SECTION 5.6 The Fundamental Theorem of Calculus

P276 The last expression on the page should be simply $\frac{f(x+\Delta x)-f(x)}{\Delta x}$. In other words, delete $f'(x) \approx$.

P276 The second equation on the page should not begin with $f'(x) \approx$. Delete that portion of the expression in the middle of the page. The rest of the expression remains.

P279 Definition 5.25 should end with the equation $\int_c^d f(x)dx = g(d) - g(c)$.

SECTION 6.1 Optimization

EXERCISES

P298 Exercise 10. Add after the 0.5 in the next-to-last sentence: "and continue to assume that the volume will be 1 cubic meter."

SECTION 6.3 Implicit Differentiation

EXERCISES

P306 Exercise 12 should read: "$\sqrt[5]{5}$"

P313 Exercise 15 The equation for the curve is $x^6 + y^6 - 4x^4 + 3x^4y^2 + 3x^2y^4 = 2$

ANSWERS

P924 Exercise 11 Answer should be $y' = 20$ at the point $(\frac{2}{3}.\frac{4}{3})$.

SECTION 6.4 Related Rates

ANSWERS

P925 Exercise 7 Answer should be ≈ 0.4729 meters/min.

P925 Exercise 11 Answer should be -3.846 percent per minute.

SECTION 6.6 Curve Sketching—Concavity and Inflection Points

ANSWERS

P928 Exercise 29 The second co-ordinate should be 0 at all inflection points, not $\pm\frac{\sqrt{2}}{2}$.

P928 Exercise 31 The first co-ordinate should be $\sqrt[3]{\frac{1}{6}}$.

SECTION 6.8 Inverse Functions

TEXT

P349 Example at top of page. The last line in the example should read "*This agrees with the direct computation of* $(f^{-1})'(y)$ *from the function* $(f^{-1})(y) = y^{\frac{1}{3}}$"
Note also that the notation $(f^{-1'})(y)$ should be $(f^{-1})'(y)$ in lines 2 and 5 in the non-boldface text in that example.

EXERCISES

P352 Exercise 15 should be $f(x) = \frac{1+x}{x}$.

SECTION 7.3 Integration by Parts

EXERCISES

P413 Exercise 41 the units are wrong. The problem should read: "An electric motor takes more energy to start than it does to keep running. Energy is power times time. At start-up the power consumption for a particular motor can be approximated by $P(t) = te^{-0.3t}$ watts. Find the energy (in watt-seconds) used by this motor in the first 5 seconds of operation."

ANSWERS

P938 Exercise 43 The answer should be $14 + \frac{57}{8}e^{\frac{5}{8}} - 16e^{\frac{1}{2}}$.

SECTION 7.4 The Method of Rectangles

TEXT

P415 In the paragraph following Proposition 7.3 the function $f(x) = e^{\frac{1}{x}x^2}$ should be $f(x) = e^{-\frac{1}{x}x^2}$ in the four places it appears in that paragraph.

P417 In the shaded box at the top of the page the interval in the first line should be $[a, b]$, not $[j, k]$.

SECTION 7.9 Vector Fields

ANSWERS

P943 Exercise 1 Picture is wrong. Arrows should go in opposite direction.

SECTION 7.11 Equilibrium Points

TEXT

P458 The last sentence on the page should refer to Section 8.9 not Section 9.1.

SECTION 8.2 Polynomial Approximations

TEXT

P517 Definition 8.2 should begin: "*Let g be a function....*"

SECTION 8.4 Taylor's Theorem

TEXT

P532 In the middle of the page; the second line in the paragraph beginning with "We've completed the first..." should denote the Maclaurin polynomial as $M_{n-1}(x)$ not $T_{n-1}(x)$

P535 For the Example, which begins on P534,the degree necessary to make the required estimate should be $n = 8$, not $n = 9$. Thus, the next-to-last sentence in that example should be: "*We find that $n = 8$ is large enough. We conclude that the degree-seven polynomial, evaluated at 9.4,...*"
The first five terms of the polynomial on the next line are correct. The general term on the next line, however, should be changed, so that the end of the example reads: "$+ \cdots + \frac{3\cdot5\cdot7\cdots11}{7!2^7 3^{13}}(9.4-9)^7$. *(*$= 3.065941943352\ldots$*) approximates*

$$\sqrt{9.4}$$

to within 10^{-9}."

EXERCISES

P537 Exercise 32. Change the first line to read: "*To approximate e^5 to within* 0.01*, which..*"

P537 Exercise 33. Change the exercise to read: "*To approximate* $\ln(2/3)$ *to within* 0.00001 *using a Taylor polynomial for* $\ln(x)$ *based at* $x = 1$ *over the interval* $(\frac{1}{2}, \frac{3}{2})$*, what degree polynomial would you need?*"

P537 Exercise 34b. The *Note* should read: "*In the preceding exercise, the interval to consider could have been* $(\frac{1}{2}, \frac{3}{2})$*. Here, the interval could be* $(\frac{3}{8}, 1\frac{5}{8})$*, because 1 is still the base point, but we wish to evaluate the polynomial at* $x = \frac{3}{2} = 1\frac{1}{2}$ *instead of at* $x = \frac{2}{3}$*. You'll need to find the greatest possible value of* $|f^{(n+1)}(x)|$ *on* $(\frac{3}{8}, 1\frac{5}{8})$."

ANSWERS

P951 Exercise 15 The answer should be "*A bound for* $|g^{(5)}(x)|$ *on* $(-1, 1)$ *is* $6e$ *which is less than 18.*"

P951 Exercise 19 The answer should be "*A bound for* $|g^{(5)}(x)|$ *on* $(-1, 1)$ *is* e^6 *which is less than 405.*"

P951 Exercise 31 The answer should read: "*Estimating* $e^6 \approx (2.8)^6$*, we find that* $n = 13$ *is sufficient. The polynomial is* $\Sigma_{j=0}^{13} \frac{x^j}{j!}$*.*"

P951 Exercise 33 The answer should be the degree-20 Taylor polynomial.

SECTION 8.8 Pharmacokinetics

ANSWERS

P952 Text in the answer to Section 8.8 Laboratory should read as follows: "*You can solve for* r*. What you can't calculate from the equations is an initial value. Try different initial values in a computer and observe the graphs. For fun try an initial value greater than 150 and see what happens. (You couldn't try this with real patients, but the mathematical result says something interesting about the stability of the equilibrium.)*"

SECTION 9.1 Infinite Sums

TEXT

P577 In Definition 9.2 line 1 should read "*For any sequence* $\mathbf{a}$ *and real number* r*, we say ...*"

P583 The general term in series F (6th down from top of page) should be $\frac{n}{5^{n-1}}$

EXERCISES

P583 The directions for **b**(Exercises 1-16) should read: "Try to decide if the series converges or diverges. If you think it converges, find (if you can) to what number the series converges. For now you'll just have to use a calculator (or spreadsheet) and take some educated guesses. In the next few sections you'll be able to determine exactly to what number some of these series converge."

SECTION 9.2 Geometric Series

ANSWERS

P956 Answers to 33 b and c should be interchanged. Answer to 33b is 900mg and Answer to 33c is 450mg.

SECTION 9.3 Taylor Series

EXERCISES

P596 Exercise 1a. The next to last line on the page in the answer to 1a should read: "*so the series is:* ." And the series should end with three lower dots ... to indicate an infinite series.

P597 Exercise 5. The interval should be $(-5, 6)$.

P597 Exercise 7. The interval should be $(-1, 3)$.

P598 Exercise 10 (begins on P597) polynomial **iii** should be $-x + \frac{x^2}{2} - \frac{x^3}{3!}$.

ANSWERS

P956 Answer to Exercise 3b should be "*The error term is at most* $\frac{(10\pi)^n}{n!}$ *on the interval* $(-2\pi, 2\pi)$."

P956 Answer to Exercise 7b should be "*This problem is tricky. The term* M_n *on the interval* $(-1, 3)$ *is* $n!$*. The error term is then* $\frac{n!}{n!}2^n$*, which doesn't go to zero as* n *goes to infinity. Nevertheless, the Taylor series does equal the function on the interval* $(-1, 3)$*. This shows that, while passing the Taylor Theorem test guarantees that the series equals the function on the given interval,* failing the Taylor Theorem test is inconclusive! "

P956 The answer to 7c should be: "*The series does equal the function on the interval* $(-1, 3)$*, even though Taylor's Theorem is inconclusive in this case.* "

P957 Exercise 13, the left | is missing in the expression $|M_{n-1}(x) - e^x|$ on line 1. Also, the answer should have another sentence added at the end, as follows: "*The reason that* $e^x > 1 + x$ *for all* x *is that all terms in the series are positive, and the series begins with* $1 + x$*.*

SECTION 9.4 Power Series

TEXT

P600 Proposition 9.10. The interval should be $(a-r, a+r)$, not (a, b). Replace (a, b) with $(a-r, a+r)$ in lines 1, 6 and 9 in the statement of the Proposition.

P602 Example. In the series in line 2 in the example the general term of the series should be $\frac{n}{5^{n-1}}$.

EXERCISES

P602 Exercise 19b. The series should be $1 - \frac{3}{2!} + \frac{3^2}{4!} - \frac{3^3}{6!} + \frac{3^4}{8!} - \frac{3^5}{10!} + \cdots$

SECTION 9.5 Bounded Series and the Comparison Test

TEXT

P604 Series F should have general term $\frac{n}{5^{n-1}}$.

P608 Second Example on that page. The second line in the last paragraph in that example: replace $x - 1$ with $x = -1$.

EXERCISES

P616 Exercise 23. Should be $\Sigma_{j=1}^{\infty} \frac{1}{5+\sqrt{j}}$

P616 Exercise 35 should be eliminated here and moved to the Exercises for Section 9.6. (Insert it as Exercise 33 in Section 9.6 P623 and renumber the remaining Exercises in that section.)

ANSWERS

P958 Exercise 17. The answer should read: "*You might be tempted to break the series into the sum of two series and say that* $\Sigma_{j=1}^{\infty} \frac{1}{j} - \frac{1}{j+1} = \Sigma_{j=1}^{\infty} \frac{1}{j} - \Sigma_{j=1}^{\infty} \frac{1}{j-1}$. *But this doesn't help since neither of these two series converge. This exercise was to alert you to this trap. The surprising fact is that the series in this exercise converges to 1. For details see the example in "Golden Oldies" for the next section (P630).*"

SECTION 9.6 Conditional and Absolute Convergence

TEXT

P617 The last word in the third line in this section should be "*arctangent*" not "sine."

P617 The text at the bottom of the page below Definition 9.16 should read: "*We can find the sum of series E'. The Maclaurin series for arctangent converges at $x = 1$ and so*

$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + - \cdots = \arctan(1) = \frac{\pi}{4}.$$"

P618 Each series should have a general term with the factor $(-1)^{n+1}$, not $(-1)^n$.

EXERCISES

P622 The instructions for Exercises 11-14 should read: "*To what functions do the following series converge?*"

P623 Exercise 28. The equation in the last line of the answer should be $1 - \frac{1}{2} + \frac{1}{3} - + \cdots = \ln(2)$.

P623 Exercise 31. The next-to-last line should read: "*diverges, even though the terms do go to 0*"

ANSWERS

P960 Exercise 13. The answer should be: "*Series converges only for $x = 0$.*"

P960 Exercise 17. The answer should be: "*On $(-9, -5)$.*"

SECTION 9.7 Intervals of Convergence

EXERCISES

P624 Exercise 4 The interval of convergence should be $(-\infty, \infty)$.

P630 Exercise 23 Add the sentence: "*Be careful here. Try computing the sequence of partial sums.*"

SECTION 10.2 Two-input Functions in Pictures

EXERCISES

P693 Exercise 41 should read: "*In what states does the change in pressure vary the most?*"

SECTION 10.3 Partial Derivatives

TEXT

P701 last line on page. Line should begin with $\frac{\partial F}{\partial y}(a, b)$

EXERCISES

P702 Exercise 8 Change interval to $(2, \pi)$.

ANSWERS

P968 Exercise 23 Both approximation signs should be equal signs.

SECTION 11.1 Complex Arithmetic

ANSWERS

P973 Exercise 15 Answer should be $\frac{1 \pm i\sqrt{3}}{2}$

SECTION 11.2 Complex Algebra and Geometry

EXERCISES

P767 Exercise 30 Instruction **c** should not be a third instruction. Eliminate the boldface **c** (But leave the sentence as it is.)

SECTION 11.3 The Radius of Convergence

TEXT

P769 The text below the top picture on the page should read: "*Now, recall that Proposition 9.22 tells us that the interval of convergence of a Maclaurin series is always symmetric about 0. That is, either the series converges for all real numbers, or else there's a real number* r *such that the series converges on* $(-r, r)$ *and diverges for* $x < -r$ *and for* $x > r$."

SECTION 11.4 The Most Beautiful Equation

ANSWERS

P976 Exercise 21 The answer should be $2e^{\frac{k\pi i}{6}}$ for $0 \leq k \leq 11$.