First Printing Errata for *Precalculus with Calculus Previews,* by Dennis G. Zill and Jacqueline M. Dewar

(Yellow highlighting indicates corrected material)

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For the Student

- *Student Resource Manual (SRM)* was prepared by Warren S. Wright and Carol Wright. This printed manual can be bundled with the text at a substantial savings compared to buying the text and SRM separately. For a complete description of this effective student tutorial, please turn to page x of this preface.

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NOTES FROM THE CLASSROOM

(*i*) On tests we see students carrying out the expansion of $(a + b)^3$ by brute force, multiplying out $(a + b)(a + b)(a + b)$. This procedure is not recommended; it is slow and you are prone to errors. Instead, you should memorize (6) and (7).

(*ii*) In *any* mathematics course—not just calculus—do not erase or leave out important steps of your work. Most mathematics instructors want to see all work. Presenting that work in a neat and orderly fashion is also to your advantage. Finally, in the case of a limit problem such as Example 9, be sure to write down the symbol $\lim_{x \to a}$ at each step. For example, we frequently see *incorrect* statements like this:

$$\lim_{x \to 1} \frac{x - 1}{x^2 - 1} = \frac{1}{x + 1} = \frac{1}{2}$$

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on students' papers. The *correct* version of the preceding line is

$$\lim_{x \to 1} \frac{x - 1}{x^2 - 1} = \lim_{x \to 1} \frac{1}{x + 1} = \frac{1}{2}.$$

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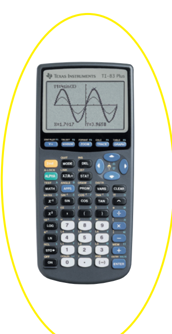

NOTES FROM THE CLASSROOM

When sketching the graph of a function, you should never resort to plotting a lot of points by hand. That is something a graphing calculator or a computer algebra system does so well. On the other hand, you should not become dependent on a calculator to obtain a graph. Believe it or not, there are precalculus and calculus instructors who do not allow the use of graphing calculators on quizzes or tests. Usually there is no objection to your using calculators or computers as an aid in checking homework problems, but in the classroom instructors want to see the product of your own mind, namely, the ability to analyze. So you are strongly encouraged to develop your graphing skills to the point where you are able to quickly sketch by hand the graph of a function from a basic familiarity of types of functions and by plotting a minimum of well-chosen points.

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EXAMPLE 3 **Inverse of a Function**

(a) Find the inverse of $f(x) = \frac{1}{2x - 3}$. **(b)** Find the domain and range of f^{-1}. Find the range of f.

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In Problems 15–18, proceed as in Example 2(b) to show that the given function f *is* one-to-one.

15. $f(x) = \frac{2}{5x + 8}$

16. $f(x) = \frac{2x - 5}{x - 1}$

17. $f(x) = \sqrt{4 - x}$

18. $f(x) = \frac{1}{x^3 + 1}$

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Find two nonnegative numbers whose sum is 15 *such that the product of one and the square of the other is a maximum.*

The big hurdle for many students is separating out the words that define the function to be optimized from all the words contained in the statement of the problem.

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In the case when c is either a simple zero or a zero of odd multiplicity $m = 3, 5, \ldots$, $f(x)$ changes sign *at* $(c, 0)$, whereas if c is a zero of even multiplicity $m = 2, 4, \ldots$, $f(x)$ does not change sign at $(c, 0)$. We note that depending on the sign of the leading coefficient of the polynomial, the graphs in Figure 3.1.6 could be reflected

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The Graph: From left to right, the graph falls (f decreasing) from the second quadrant and then, because -1 is a zero of multiplicity 2, the graph is tangent to the x-axis at $(-1, 0)$. The graph then rises (f increasing) as it passes through the y-intercept $(0, 1)$. At some point within the interval $[-1, 1]$ the graph turns downward (f decreasing) and, since 1 is a simple zero, passes through the x-axis at $(1, 0)$, heading downward into the fourth quadrant. See FIGURE 3.1.8. ■

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In Example 3, there are again two turning points. It should be clear that the point $(-1, 0)$ is a turning point (f changes from decreasing to increasing at this point) and is a relative minimum of f. There is a turning point (f changes from increasing to decreasing at this point) on the interval $[-1, 1]$ and is a relative maximum of f.

The Graph: From left to right, the graph rises from the third quadrant and then, because -4 is a simple zero, the graph of f passes directly through the x-axis at $(-4, 0)$. Somewhere within the interval $[-4, 0]$ the function f must change from increasing to decreasing to enable its graph to pass through the y-intercept $(0, 32)$. After its graph passes through the y-intercept, the function f continues to decrease but, since 2 is a zero of multiplicity 3, its graph flattens as it passes through $(2, 0)$, heading downward into the fourth quadrant. See FIGURE 3.1.10. ■

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NOTES FROM THE CLASSROOM

We assumed throughout the foregoing discussion that the degree of the numerator $P(x)$ was less than the degree of the denominator $Q(x)$. If, however, the degree of $P(x)$ is greater than or equal to the degree of $Q(x)$, then $P(x)/Q(x)$ is an **improper fraction**. We can still do partial fraction decomposition but the process starts with long division until a polynomial quotient and a proper fraction is attained. For example, long division gives

improper fraction ↓ ↓ proper fraction

$$\frac{x^3 + x - 1}{x^2 - 3x} = x + 3 + \frac{10x - 1}{x(x - 3)}.$$

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52. Find both the degree and the radian measures of the smallest positive angle formed by the hands of a clock **(a)** at 8:00, **(b)** at 1:00, and **(c)** at 7:30.

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EXAMPLE 4 Using Periodicity and a Reference Angle

Find exact values of $\sin t$ and $\cos t$ for $t = 29\pi/6$.

Solution Since $29\pi/6$ is greater than 2π, we rewrite $29\pi/6$ as an integer multiple of 2π plus a number less than 2π:

$$\frac{29\pi}{6} = 4\pi + \frac{5\pi}{6} = 2(2\pi) + \frac{5\pi}{6}.$$

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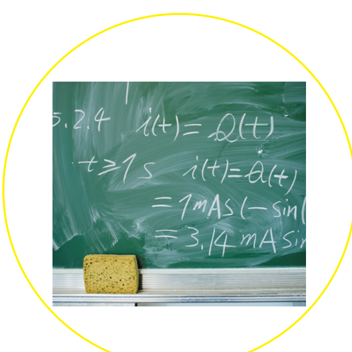

NOTES FROM THE CLASSROOM

(*i*) Should you memorize all the identities presented in this section? You should consult your instructor about this, but in the opinion of the authors, you should at the very least memorize formulas (1)–(8), (14), (15), and the two formulas in (18).

(*ii*) When you enroll in a calculus course, check the title of your text. If it has the words *Early Transcendentals* in its title, then your knowledge of the graphs and properties of the trigonometric functions will come into play almost immediately.

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□ **An Important Trigonometric Limit** To do the calculus of the trigonometric functions, $\sin x$, $\cos x$, $\tan x$, and so on, it is important to realize that the variable x is a real number or an angle x measured in radians. With that in mind, consider the numerical values of $(\sin x)/x$ as x approaches 0 from the right $(x \to 0^+)$ given in the table that follows.

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78. A farmer wishes to enclose a pasture in the form of a right triangle using 2000 ft of fencing on hand. See FIGURE 4.R.14. Show that the area of the pasture as a function of the indicated angle θ is

$$A(\theta) = \frac{1}{2}\cot\theta \cdot \left(\frac{2000}{1 + \cot\theta + \csc\theta}\right)^2.$$

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In Problems 53–58, use the one-to-one property (10) to solve the given logarithmic equation.

53. $\log_2 x - \log_2 10 = \log_2 9.3$
54. $\ln 3 + \ln(2x - 1) = \ln 4 + \ln(x + 1)$
55. $\ln x + \ln(x - 2) = \ln 3$
56. $\ln(x + 3) + \ln(x - 4) - \ln x = \ln 3$

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11. Do this problem without using the exponential model (3). Initially there are 400 grams of a radioactive substance on hand. If the half-life of the substance is 8 hours, give an educated guess of how much remains (approximately) after 17 hours. After 23 hours. After 33 hours.

16. Strontium 90 is a dangerous radioactive substance found in acid rain. As such it can make its way into the food chain by polluting the grass in a pasture on which milk cows graze. The half-life of strontium 90 is 29 years.

(a) Find an exponential model (3) for the amount remaining after t years.

(b) Suppose a pasture is found to contain Str-90 that is 3 times a safe level A_0. How long will it be before the pasture can be used again for grazing cows?

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49. acid rain: pH $= 3.8$, clean rain: pH $= 5.6$

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26. A Curiosity The logarithm developed by John Napier (see page 319) was actually

$$10^7 \log_{1/e}\left(\frac{x}{10^7}\right).$$

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Referring to Figure 6.2.3, we see that the points F_1, F_2, and P form a triangle. Because the sum of the lengths of any two sides of a triangle is greater than the remaining side, we must have $2a > 2c$ or $a > c$. Hence, $a^2 - c^2 > 0$. When we let $b^2 = a^2 - c^2$, then (3) becomes $b^2x^2 + a^2y^2 = a^2b^2$. Dividing this last equation by a^2b^2 gives

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Using $d_1 - d_2 = \pm 2a$, the last two inequalities imply that $2a < 2c$ or $a < c$. since $c > a > 0$, $c^2 - a^2$ is a positive constant. If we let $b^2 = c^2 - a^2$, (3) becomes $b^2x^2 - a^2y^2 = a^2b^2$ or, after dividing by a^2b^2,

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and
$$\frac{(y-k)^2}{a^2} - \frac{(x-h)^2}{b^2} = 1. \tag{11}$$

As in (4) and (5), the numbers a^2, b^2, and c^2 are related by $b^2 = c^2 - a^2$.

You can locate vertices and foci using the fact that a is the distance from the center to a vertex and c is the distance from the center to a focus. The slant asymptotes for (10) can be obtained by factoring

$$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 0$$

as
$$\left(\frac{x-h}{a} - \frac{y-k}{b}\right)\left(\frac{x-h}{a} + \frac{y-k}{b}\right) = 0.$$

Similarly, the asymptotes for (11) can be obtained from factoring $\frac{(y-k)^2}{a^2} - \frac{(x-h)^2}{b^2} = 0$, setting each factor equal to zero and solving for y in terms of x. As a check on your work, remember that (h, k) must be a point that lies on each asymptote.

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Polar Equations of Conics Equation (1) is readily interpreted using polar coordinates. Suppose F is placed at the pole and L is p units $(p > 0)$ to the left of F perpendicular to the extended polar axis. We see from FIGURE 6.6.2 that (1) written as $d(P, F) = ed(P, Q)$ is the same as

$$r = e(p + r\cos\theta) \qquad \text{or} \qquad r - er\cos\theta = ep. \tag{2}$$

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Applications Equations of the type in (5) and (6) are well-suited to describe a closed orbit of satellite around the Sun (Earth or Moon) since such an orbit is an ellipse with the Sun (Earth or Moon) at one focus. Suppose that an equation of the orbit is given by $r = ep/(1 - e\cos\theta)$, $0 < e < 1$, and r_p is the value of r at perihelion (perigee

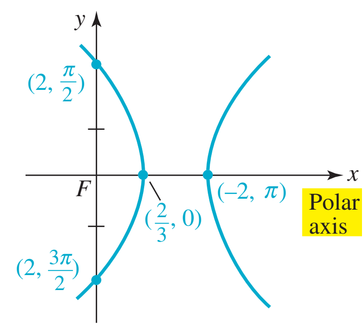

FIGURE 6.6.6 Graph of polar equation in Example 4

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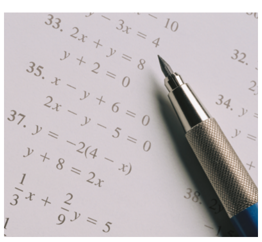

NOTES FROM THE CLASSROOM

In this section we have focused on **plane curves,** curves C defined parametrically in two dimensions. In the study of multivariable calculus you will see curves and surfaces in three dimensions that are defined by means of parametric equations. For example, a **space curve** C consists of a set of ordered triples $(f(t), g(t), h(t))$, where f, g, and h are defined on a common interval. Parametric equations for C are $x = f(t)$, $y = g(t)$, $z = h(t)$. For example, the **circular helix** such as shown in FIGURE 6.7.9 is a space curve whose parametric equations are

$$x = a\cos t, \quad y = a\cos t, \quad z = bt, \quad t \geq 0. \tag{5}$$

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In Problems 51–62, identify and sketch the graph of the given polar equation.

51. $r = 5$ **52.** $\theta = -\pi/3$

53. $r = 5\sin\theta$ **54.** $r = -4\cos\theta$

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Chapter 1 Review Exercises Page 46

1. $x \le 9$
3. II
5. $(2, -3)$
7. $(x + 2)^2 + (y + 5)^2 = 36$
9. $\sqrt{10}$
11. $(-\frac{5}{2}, 0), (\frac{5}{2}, 0), (0, -5)$
13. center $(8, 0)$, radius 8
15. $(-3, 4), (-3, -4)$
17. $x^2 + y^2 > 36$
19. $|x - \sqrt{2}| > 3$
21. false **23.** true **25.** false **27.** true
29. true **31.** true **33.** false **35.** true
37. true
39. true
41. $a^2 < ab$
43. $a < a + b$
45. 10
47. $\le$
49. $-4 \le x \le 3$
51. $a = 4, b = 6$
53. $(-\infty, -3)$
55. $(4, 12)$
57. $(-\infty, -10) \cup (10, \infty)$
59. $(-\frac{1}{3}, 3)$
61. $[-1, \frac{5}{2}$
63. $(-1, 0) \cup (1, \infty)$
65. $(0, 1) \cup (1, \infty)$
67. **(a)** $\dfrac{1}{2x + 1}, x \ne \dfrac{1}{2}$ **(b)** $\frac{1}{2}$
69. **(a)** $(x + 4)(\sqrt{x} + 2), x \ne 4$ **(b)** 32

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27. $f(x) = x - x^2; (-\infty, \infty)$
29. $F(x) = 2x + \dfrac{16{,}000}{x}; (0, \infty)$
31. $C(x) = 4x + \dfrac{640{,}000}{x}; (0, \infty)$
33. **(a)** $3x + 3a$ **(b)** $f'(a) = 6a$
35. **(a)** $10(x^2 + ax + a^2)$ **(b)** $f'(a) = 30a^2$
37. **(a)** $\dfrac{-1}{ax}$ **(b)** $f'(a) = \dfrac{-1}{a^2}$
39. **(a)** $\dfrac{\sqrt{7}}{\sqrt{x} + \sqrt{a}}$ **(b)** $f'(a) = \dfrac{1}{2}\sqrt{\dfrac{7}{a}}$

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27. $0, 1, 3, -1 - \sqrt{2}, -1 + \sqrt{2};$
$f(x) = 4x(x - 1)(x - 3)(x + 1 + \sqrt{2})(x + 1 - \sqrt{2})$

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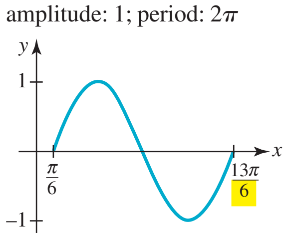
33. amplitude: 1; period: 2π



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31. no solution **33.** 15.80 ft **35.** 9.1 m **37.** 10.35 ft.