94. True. The degree of the numerator (3) is larger than the degree of the denominator (2).

96.

$$\begin{array}{r} x^{2n} + 6x^n + 9 \\ x^n + 3 \overline{\smash{)}\, x^{3n} + 9x^{2n} + 27x^n + 27} \\ \underline{x^{3n} + 3x^{2n}} \qquad\qquad\quad \\ 6x^{2n} + 27x^n \qquad \\ \underline{6x^{2n} + 18x^n} \qquad \\ 9x^n + 27 \\ \underline{9x^n + 27} \\ 0 \end{array}$$

$$\frac{x^{3n} + 9x^{2n} + 27x^n + 27}{x^n + 3} = x^{2n} + 6x^n + 9$$

[Note: let $y = x^n$ and calculate $(y^3 + 9y^2 + 27y + 27) \div (y + 3)$]

98. A divisor divides evenly into the dividend if the remainder is zero.

100. (a) $(f \circ g)(x) = f(x + 4) = (x + 4)^2$

(b) $(g \circ f)(x) = g(x^2) = x^2 + 4$

102. (a) $(f \circ g)(x) = f(x - 3) = |x - 3| + 2$

(b) $(g \circ f)(x) = g(|x| + 2) = (|x| + 2) - 3 = |x| - 1$

104. $(x - 0)(x + 12) = x^2 + 12x$

106. $(x - 0)(x + 1)(x - 2)(x - 5) = (x^2 + x)(x^2 - 7x + 10)$

$= x^4 - 6x^3 + 3x^2 + 10x$

Section 2.4 Complex Numbers

Solutions to Even-Numbered Exercises

2. $a + bi = 12 + 5i$

$a = 12$

$b = 5$

4. $(a + 6) + 2bi = 6 - 5i$

$2b = -5$

$b = -\frac{5}{2}$

$a + 6 = 6$

$a = 0$

6. $3 + \sqrt{-9} = 3 + 3i$

8. $42 = 42 + 0i$

10. $-3i^2 + i = -3(-1) + i$

$= 3 + i$

12. $\left(\sqrt{-4}\right)^2 - 7 = -4 - 7$

$= -11$

14. $\sqrt{-0.0004} = 0.02i$

16. $(11 - 2i) + (-3 + 6i) = 8 + 4i$

18. $\left(7 + \sqrt{-18}\right) - \left(3 + 3\sqrt{2}i\right) = 7 + 3\sqrt{2}i - 3 - 3\sqrt{2}i = 4$

20. $22 + (-5 + 8i) + 10i = 17 + 18i$

22. $-\left(\frac{3}{4} + \frac{7}{5}i\right) - \left(\frac{5}{6} - \frac{1}{6}i\right) = -\frac{3}{4} - \frac{5}{6} - \frac{7}{5}i + \frac{1}{6}i$

$= -\frac{19}{12} - \frac{37}{30}i$

24. $-(-3.7 - 12.8i) - \left(6.1 - \sqrt{-24.5}\right) = 3.7 + 12.8i - 6.1 + \sqrt{\frac{49}{2}}i$

$$= -2.4 + \left(12.8 + \frac{7\sqrt{2}}{2}\right)i$$

$$\approx -2.4 + 17.75i$$

26. $\sqrt{-5} \cdot \sqrt{-10} = \left(\sqrt{5}i\right)\left(\sqrt{10}i\right)$

$$= \sqrt{50}i^2 = 5\sqrt{2}(-1) = -5\sqrt{2}$$

28. $\left(\sqrt{-75}\right)^2 = \left(\sqrt{75}i\right)^2 = 75i^2 = -75$

30. $(6 - 2i)(2 - 3i) = 12 - 18i - 4i + 6i^2$

$$= 12 - 22i - 6$$

$$= 6 - 22i$$

32. $-8i(9 + 4i) = -72i - 32i^2$

$$= 32 - 72i$$

34. $\left(3 + \sqrt{-5}\right)\left(7 - \sqrt{-10}\right) = \left(3 + \sqrt{5}i\right)\left(7 - \sqrt{10}i\right)$

$$= 21 - 3\sqrt{10}i + 7\sqrt{5}i - \sqrt{50}i^2$$

$$= 21 + \sqrt{50} + 7\sqrt{5}i - 3\sqrt{10}i$$

$$= \left(21 + 5\sqrt{2}\right) + \left(7\sqrt{5} - 3\sqrt{10}\right)i$$

36. $(1 - 2i)^2 - (1 + 2i)^2 = 1 - 4i + 4i^2 - (1 + 4i + 4i^2)$

$$= 1 - 4i + 4i^2 - 1 - 4i - 4i^2$$

$$= -8i$$

38. The error is $\sqrt{-4} \neq 4i$. The correct statement is $\sqrt{-4} = 2i$.

40. $(8 - 12i)(8 + 12i) = 8^2 - (12i)^2$

$$= 8^2 + 12^2$$

$$= 64 + 144 = 208$$

42. $\left(-3 + \sqrt{2}i\right)\left(-3 - \sqrt{2}i\right) = (-3)^2 - \left(\sqrt{2}i\right)^2$

$$= 9 + 2 = 11$$

44. $\sqrt{-13} = \sqrt{13}i \cdot \left(\sqrt{13}i\right)\left(-\sqrt{13}i\right) = 13$

46. $\left(1 + \sqrt{-8}\right)\left(1 - \sqrt{-8}\right) = \left(1 + \sqrt{8}i\right)\left(1 - \sqrt{8}i\right)$

$$= 1 + 8 = 9$$

48. $-\frac{5}{i} \cdot \frac{i}{i} = \frac{-5i}{-1} = 5i$

50. $\frac{3}{1 - i} \cdot \frac{1 + i}{1 + i} = \frac{3 + 3i}{1 - i^2} = \frac{3 + 3i}{2} = \frac{3}{2} + \frac{3}{2}i$

52. $\frac{8 - 7i}{1 - 2i} \cdot \frac{1 + 2i}{1 + 2i} = \frac{8 + 16i - 7i - 14i^2}{1 - 4i^2}$

$$= \frac{22 + 9i}{5} = \frac{22}{5} + \frac{9}{5}i$$

54. $\frac{8 + 20i}{2i} \cdot \frac{-2i}{-2i} = \frac{-16i - 40i^2}{-4i^2} = 10 - 4i$

56. $\dfrac{(2-3i)(5i)}{2+3i} \cdot \dfrac{2-3i}{2-3i} = \dfrac{(10i-15i^2)(2-3i)}{4-9i^2}$
$= \dfrac{20i-30i^2-30i^2+45i^3}{13}$
$= \dfrac{60+20i-45i}{13}$
$= \dfrac{60-25i}{13} = \dfrac{60}{13} - \dfrac{25}{13}i$

58. $\dfrac{2i}{2+i} + \dfrac{5}{2-i} = \dfrac{2i(2-i)}{(2+i)(2-i)} + \dfrac{5(2+i)}{(2+i)(2-i)}$
$= \dfrac{4i-2i^2+10+5i}{4-i^2}$
$= \dfrac{12+9i}{5}$
$= \dfrac{12}{5} + \dfrac{9}{5}i$

60. $4i^2 - 2i^3 = -4 + 2i$

62. $(-i)^3 = (-1)(i^3) = (-1)(-i) = i$

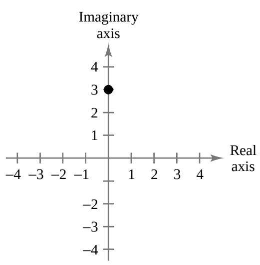
64. $\left(\sqrt{-2}\right)^6 = \left(\sqrt{2}\,i\right)^6 = 8i^6 - 8i^4i^2 = -8$

66. $\dfrac{1}{(2i)^3} = \dfrac{1}{8i^3} = \dfrac{1}{-8i} \cdot \dfrac{8i}{8i} = \dfrac{8i}{-64i^2} = \dfrac{1}{8}i$

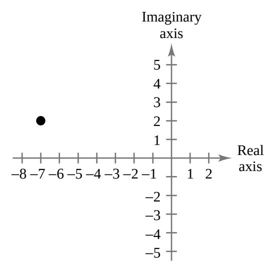
68. $-1 - 2i$

70. $2 - 6i$

72.



74.



76. 2

$2^2 + 2 = 6$
$6^2 + 2 = 38$
$38^2 + 2 = 1446$
$1446^2 + 2 = 2{,}090{,}918$
4.4×10^{12}

Not bounded. $c = 2$ is not in the Mandelbrot Set.

78. $-i$

$(-i)^2 - i = -1 - i$
$(-1-i)^2 - i = i$
$i^2 - i = -1 - i$
$(-1-i)^2 - i = i$
$i^2 - i = -1 - i$

Bounded. $c = -i$ is in the Mandelbrot Set.

80. -1

$(-1)^2 - 1 = 0$
$0^2 - 1 = -1$
$(-1)^2 - 1 = 0$
$0^2 - 1 = -1$
$(-1)^2 - 1 = 0$

Bounded. $c = -1$ is in the Mandelbrot Set.

82. $2^4 = 16,\ (-2)^4 = 16$

$(2i)^4 = 2^4i^4 = 16(1) = 16$
$(-2i)^4 = (-2)^4i^4 = 16(1) = 16$

84. False. A real number $a + 0i = a$ is equal to its conjugate.

86. False. $i^{44} + i^{150} - i^{74} - i^{109} + i^{61} = 1 - 1 + 1 - i + i = 1$

88. $(a + bi) + (a - bi) = 2a$, a real number

$(a + bi) - (a - bi) = 2bi$, an imaginary number