101. False. This is not an application of the Zero Factor Property because there are unlimited number of factors whose product is 1.

103. The maximum number of solutions of an n^{th} degree polynomial equation is n. The third-degree equation $(x + 1)^3 = 0$ has only one solution, $x = -1$.

Review Exercises for Chapter 3

1. $x^2 + 2 + 3x^{1/2}$ is not a polynomial because the exponent of a variable must be a natural number.

3. Standard form: $-x^4 + 6x^3 + 5x^2 - 4x$

Leading coefficient: -1

Degree: 4

5. Standard form: $-7x^3 + 3x^2 - 6x + 14$

Leading coefficient: -7

Degree: 3

7. Binomial of degree 4: $3x^4 - 2$

9. Monomial of degree 3 and leading coefficient 5: $5x^3$

11. $(5x + 3x^2) + (6 - x - 4x^2) = (3x^2 - 4x^2) + (5x - x) + 6 = -x^2 + 4x + 6$

13. $(5x^3 - 6x + 11) + (5 + 6x - x^2 - 8x^3) = (5x^3 - 8x^3) - x^2 + (-6x + 6x) + (11 + 5) = -3x^3 - x^2 + 16$

15. $(3t - 5) - (t^2 - t - 5) = (3t - 5) + (-t^2 + t + 5) = -t^2 + (3t + t) + (-5 + 5) = -t^2 + 4t$

17. $$\begin{aligned}(3x^5 + 4x^2 - 8x + 12) - (2x^5 + x) + (3x^2 - 4x^3 - 9) &= (3x^5 - 2x^5) - 4x^3 + (4x^2 + 3x^2) + (-8x - x) + (12 - 9)\\ &= x^5 - 4x^3 + 7x^2 - 9x + 3\end{aligned}$$

19. $$\begin{aligned}(-x^3 - 3x) - 4(2x^3 - 3x + 1) &= -x^3 - 3x - 8x^3 + 12x - 4\\ &= (-x^3 - 8x^3) + (-3x + 12x) + (-4)\\ &= -9x^3 + 9x - 4\end{aligned}$$

21. $$\begin{aligned}3y^2 - [2y + 3(y^2 + 5)] &= 3y^2 - [2y + 3y^2 + 15]\\ &= 3y^2 - 2y - 3y^2 - 15\\ &= (3y^2 - 3y^2) - 2y - 15\\ &= -2y - 15\end{aligned}$$

23. $x^2 \cdot x^3 = x^{2+3} = x^5$

25. $(u^2)^3 = u^{2 \cdot 3} = u^6$

27. $$\begin{aligned}(-2z)^3 &= (-2)^3 z^3\\ &= -8z^3\end{aligned}$$

29. $$\begin{aligned}-(u^2v)^2(-4u^3v) &= -(u^4v^2)(-4u^3v)\\ &= 4u^{4+3}v^{2+1}\\ &= 4u^7v^3\end{aligned}$$

31. $\dfrac{12z^5}{6z^2} = \left(\dfrac{12}{6}\right) \cdot z^{5-2} = 2z^3$

33. $$\begin{aligned}\frac{120u^5v^3}{15u^3v} &= \frac{120}{15} \cdot \frac{u^5}{u^3} \cdot \frac{v^3}{v}\\ &= 8u^2v^2\end{aligned}$$

35. $$\begin{aligned}\left(\frac{72x^4}{6x^2}\right)^2 &= (12x^{4-2})^2\\ &= (12x^2)^2\\ &= 144x^4\end{aligned}$$

37. $(-2x)^3(x+4) = -8x^3(x+4)$
$= -8x^4 - 32x^3$

39. $3x(2x^2 - 5x + 3) = 6x^3 - 15x^2 + 9x$

41. $(x-2)(x+7) = x^2 + 7x - 2x - 14$
$= x^2 + 5x - 14$

43. $(5x+3)(3x-4) = 15x^2 - 20x + 9x - 12 = 15x^2 - 11x - 12$

45. $(4x^2+3)(6x^2+1) = 24x^4 + 4x^2 + 18x^2 + 3 = 24x^4 + 22x^2 + 3$

47. $(2x^2 - 3x + 2)(2x+3) = 2x^2(2x+3) - 3x(2x+3) + 2(2x+3)$
$= 4x^3 + 6x^2 - 6x^2 - 9x + 4x + 6$
$= 4x^3 + (6x^2 - 6x^2) + (-9x + 4x) + 6$
$= 4x^3 - 5x + 6$

49. $2u(u-7) - (u+1)(u-7) = 2u(u-7) - u(u-7) - 1(u-7)$
$= 2u^2 - 14u - u^2 + 7u - u + 7$
$= (2u^2 - u^2) + (-14u + 7u - u) + 7$
$= u^2 - 8u + 7$

51. $(4x-7)^2 = (4x)^2 - 2(4x)(7) + (-7)^2$
$= 16x^2 - 56x + 49$

53. $(2x+3y)^2 = (2x)^2 + 2(2x)(3y) + (3y)^2$
$= 4x^2 + 12xy + 9y^2$

55. $(5u-8)(5u+8) = (5u)^2 - 8^2$
$= 25u^2 - 64$

57. $(2u+v)(2u-v) = (2u)^2 - v^2 = 4u^2 - v^2$

59. $[(u-3)+v][(u-3)-v] = (u-3)^2 - v^2 = u^2 - 2(u)(3) + (-3)^2 - v^2 = u^2 - 6u + 9 - v^2$

61. $6x^2 + 15x^3 = 3x^2(2 + 5x)$

63. $28(x+5) - 70(x+5)^2 = 14(x+5)[2 - 5(x+5)]$
$= 14(x+5)(2 - 5x - 25)$
$= 14(x+5)(-5x - 23)$
$= -14(x+5)(5x+23)$

65. $v^3 - 2v^2 - v + 2 = v^2(v-2) - 1(v-2)$
$= (v-2)(v^2 - 1)$
$= (v-2)(v-1)(v+1)$

67. $t^3 + 3t^2 + 3t + 9 = t^2(t+3) + 3(t+3)$
$= (t^2+3)(t+3)$

69. $x^2 - 36 = x^2 - 6^2 = (x-6)(x+6)$

71. $9a^2 - 100 = (3a-10)(3a+10)$

73. $(u+6)^2 - 81 = (u+6-9)(u+6+9)$
$= (u-3)(u+15)$

75. $u^3 - 1 = (u-1)(u^2 + u + 1)$

77. $8x^3 + 27 = (2x)^3 + (3)^3$
$= (2x + 3)(4x^2 - 6x + 9)$

79. $x^2 - 18x + 81 = x^2 - 2(9)x + 9^2 = (x - 9)^2$

81. $4s^2 + 40st + 100t^2 = (2s)^2 + 2(2s)(10) + (10t)^2$
$= (2s + 10t)^2$

83. $x^2 + 2x - 35 = (x + 7)(x - 5)$

85. $2x^2 - 7x + 6 = (2x - 3)(x - 2)$

87. $18x^2 + 27x + 10 = (3x + 2)(6x + 5)$

89. $4a - 64a^3 = 4a(1 - 16a^2)$
$= 4a(1 - 4a)(1 + 4a)$

91. $8x(2x - 3) - 4(2x - 3) = (2x - 3)(8x - 4)$
$= (2x - 3)(2x - 1)$
$= 4(2x - 3)(2x - 1)$

93. $\frac{1}{4}x^2 + xy + y^2 = \left(\frac{1}{2}x\right)^2 + 2\left(\frac{1}{2}\right)xy + y^2$
$= \left(\frac{1}{2}x + y\right)^2$

95. $4u^2 - 28u + 49 = (2u)^2 - 2(2u)(7) + 7^2$
$= (2u - 7)^2$

97. $x^2 - 10x + 25 - y^2 = (x - 5)^2 - y^2$
$= [(x - 5) - y][(x - 5) + y]$
$= (x - 5 - y)(x - 5 + y)$
$= (x - y - 5)(x + y - 5)$

99. $3s^2 - 2s - 8 = 0$
$(3s + 4)(s - 2) = 0$
$3s + 4 = 0 \qquad s - 2 = 0$
$s = -\frac{4}{3} \qquad s = 2$

101. $v^2 - 100 = 0$
$(v - 10)(v + 10) = 0$
$v - 10 = 0 \qquad v + 10 = 0$
$v = 10 \qquad v = -10$

103. $10x(x - 3) = 0$
$10x = 0 \qquad x - 3 = 0$
$x = 0 \qquad x = 3$

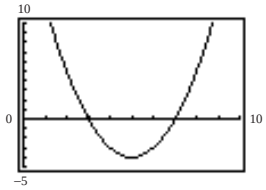
105. $z(5 - z) + 36 = 0$
$5z - z^2 + 36 = 0$
$z^2 - 5z - 36 = 0$
$(z - 9)(z + 4) = 0$
$z - 9 = 0 \qquad z + 4 = 0$
$z = 9 \qquad z = -4$

107. $2y^4 + 2y^3 - 24y^2 = 0$
$2y^2(y^2 + y - 12) = 0$
$2y^2(y + 4)(y - 3) = 0$
$2y^2 = 0 \quad y + 4 = 0 \quad y - 3 = 0$
$y = 0 \qquad y = -4 \qquad y = 3$

109. *Keystrokes:*

Y= X,T,θ x² − 10 X,T,θ + 21 GRAPH

The x-intercepts are 3 and 7, so the solutions are 3 and 7.



111. $x = 5 \quad x = -9$

$(x - 5)(x + 9) = 0$

$x^2 + 9x - 5x - 45 = 0$

$x^2 + 4x - 45 = 0$

113. $x = 0 \quad x = -\frac{3}{2} \quad x = 2$

$x\left(x + \frac{3}{2}\right)(x - 2) = 0$

$x(2x + 3)(x - 2) = 0$

$x(2x^2 - 4x + 3x - 6) = 0$

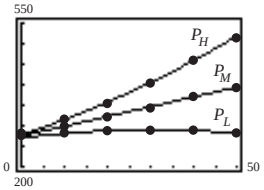
$2x^3 - x^2 - 6x = 0$

115. (a) *Keystrokes:*

y_1 [Y=] [(−)] .022 [X,T,θ] [x^2] [+] 1.33 [X,T,θ] [+] 270.71 [ENTER]

y_2 2.386 [X,T,θ] [+] 274.857 [ENTER]

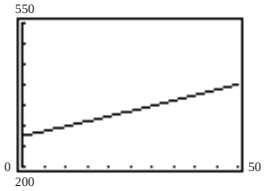
y_3 .028 [X,T,θ] [x^2] [+] 3.4 [X,T,θ] [+] 278.18 [GRAPH]



(b) $\dfrac{P_L + P_H}{2} = \dfrac{-0.022t^2 + 1.33t + 270.71 + 0.028t^2 + 3.40t + 278.18}{2}$

$= \dfrac{0.006t^2 + 4.73t + 548.89}{2}$

$= 0.003t^2 + 2.365t + 274.445$



This graph is most like the graph of P_M, the average of the high and low projections.

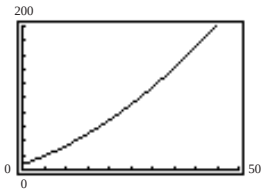
(c) $P_H - P_L = (0.028t^2 + 3.40t + 278.18) - (-0.022t^2 + 1.33t + 270.71)$

$= (0.028t^2 + 0.022t^2) + (3.40t - 1.33t) + (278.18 - 270.71)$

$= 0.05t^2 + 2.07t + 7.47$

Keystrokes: [Y=] .003 [X,T,θ] [x^2] [+] 2.365 [X,T,θ] [+] 274.495 [GRAPH]

Keystrokes: [Y=] .05 [X,T,θ] [x^2] [+] 2.07 [X,T,θ] [+] 7.47 [GRAPH]



The difference between the high and low projections is increasing.

117. *Verbal model:* [Profit] = [Revenue] − [Cost]

Equation: $P(x) = 1.1x - (0.5x + 1000)$

$= 1.1x - 0.5x - 1000$

$= 0.6x - 1000$

$P(5000) = 0.6(5000) - 1000$

$= 3000 - 1000$

$= \$2000$

119. Perimeter $= x + 3x + 4 + 4x + 3 + 1 = 8x + 8$

Area $= 1.3x + 3.4x = 3x + 12x = 15x$

121. *Verbal model:* [Area of shaded region] = [Area of larger rectangle] − [Area of smaller rectangle]

Labels:

Width of larger rectangle $= 2x$

Length of larger rectangle $= 2x + 5$

Width of smaller rectangle $= 2x - 3$

Length of smaller rectangle $= 2x + 1$

Equation:

$$\begin{aligned}\text{Area} &= 2x(2x + 5) - (2x + 1)(2x - 3)\\ &= 4x^2 + 10x - (4x^2 - 6x + 2x - 3)\\ &= 4x^2 + 10x - 4x^2 + 4x + 3\\ &= 14x + 3\end{aligned}$$

123. (a) $\begin{aligned}\text{Perimeter} &= 2l + 2w\\ &= 2l + 2(l - 5)\\ &= 2l + 2l - 10\\ &= 4l - 10\end{aligned}$

(b) $\begin{aligned}\text{Area} &= l \cdot w\\ &= l(l - 5)\\ &= l^2 - 5l\end{aligned}$

125. *Verbal model:* [Cost of fencing 2 widths] + [Cost of fencing front] + [Cost of fencing back] = [9500]

Labels:

Width $= x$

Front $= 400 - x$

Back $= 400 - x$

Equation:

$$\begin{aligned}10(2x) + 15(400 - x) + 10(400 - x) &= 9500\\ 20x + 6000 - 15x + 4000 - 10x &= 9500\\ -5x &= -500\\ x &= 100 \text{ feet}\\ 400 - x &= 300 \text{ feet}\end{aligned}$$

127. $-16t^2 + 16t + 32 = 0$

$-16(t^2 - t - 2) = 0$

$-16(t - 2)(t + 1) = 0$

$t - 2 = 0$ $\qquad$ $t + 1 = 0$

$t = 2$ $\qquad$ $t = -1$

reject

The object reaches the ground after 2 seconds.

129. *Verbal model:* [First even integer] · [Second even] = [224]

Labels: First even integer $= 2n$

Second even integer $= 2n + 2$

Equation: $2n \cdot (2n + 2) = 224$

$4n^2 + 4n - 224 = 0$

$4(n^2 + n - 56) = 0$

$4(n + 8)(n - 7) = 0$

$n + 8 = 0$ $\qquad$ $n - 7 = 0$

$n = -8$ $\qquad$ $n = 7$

reject $\qquad$ $2n = 14$

$2n + 2 = 16$

Chapter Test for Chapter 3

1. $-5.2x^3 + 3x^2 - 8$

Degree $= 3$ $\quad$ Leading coefficient $= -5.2$

2. $\dfrac{4}{x^2 + 2}$ is not a polynomial because the variable appears in the denominator.

3. (a) $(5a^2 - 3a + 4) + (a^2 - 4) = 6a^2 - 3a$

(b) $(16 - y^2) - (16 + 2y + y^2)$

$= 16 - y^2 - 16 - 2y - y^2$

$= -2y^2 - 2y$

4. (a) $-2(2x^4 - 5) + 4x(x^3 + 2x - 1)$

$= -4x^4 - 10 + 4x^4 + 8x^2 - 4x$

$= 8x^2 - 4x + 10$

(b) $4t - [3t - (10t + 7)] = 4t - [3t - 10t - 7]$

$= 4t - 3t + 10t + 7$

$= 11t + 7$

5. (a) $(-2u^2v)^3(3v^2) = (-8u^6v^3)(3v^2)$

$= -24u^6v^5$

(b) $3(5x)(2xy)^2 = 3(5x)(4x^2y^2)$

$= 60x^3y^2$

6. (a) $2y\left(\dfrac{y}{4}\right)^2 = 2y\left(\dfrac{y^2}{16}\right)$

$= \dfrac{y^3}{8}$

(b) $\dfrac{(-3x^2y)^4}{6x^2} = \dfrac{81x^8y^4}{6x^2}$

$= \dfrac{27x^6y^4}{2}$

7. (a) $-3x(x - 4) = -3x^2 + 12x$

(b) $(2x - 3y)(x + 5y) = 2x^2 + 7xy - 15y^2$

8. (a) $(x - 1)[2x + (x - 3)] = (x - 1)(3x - 3) = 3x^2 - 6x + 3$

(b) $(2s - 3)(3s^2 - 4s + 7) = 6s^3 - 8s^2 + 14s - 9s^2 + 12s - 21$

$= 6s^3 - 17s^2 + 26s - 21$