IM2 Book 1 Selected Answers

IM2 Dream Team

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1. $x = -3$
2. –
3. (a) $x(x+4)$
   (b) $3x(x-5)$
   (c) $-x(2x+7)$
4. (a) $x = 0, 4$
   (b) $x = 0, 5$
   (c) $x = 0, -\frac{7}{2}$
5.

$2 \leq x$	–	all values that are at least 2	–
$-4 < x < 0$	–	–	$(-4, 0)$
$x < 1$	–	all values that are less than 1	$(-\infty, 1)$

6. Answers may vary. Soln: $(0, 5)$. Non-soln: $(0, 0)$.
7. $4a^2, 2a^2$
8. (a) –
   (b) $24 \leq x$
9. $(x+4)(x+1)$. 4 and 1 add to 5 and multiply to 4.
10. $x^2 + (q+p)x + pq$. $\nabla = (q+p)$. $\Delta = pq$.
11. (a) –
    (b) $37 \leq 37$
    (c) –
    (d) $x \geq 18$
12. $x = 1, -4, \frac{3}{2}$
13. (a) Answers may vary.
    System soln: $(2, 4)$
    Soln to one eqn but not the other: $(0, 0)$
    Not a system soln: $(0, 0)$

(b) –

(c) One solution.

14. Answers may vary.

$$\begin{cases} y = x \\ y = x + 1 \end{cases}$$

15. Answers may vary.

$$\begin{cases} y = x \\ 2y = 2x \end{cases}$$

16. $(3x)^2$

17. $x > -5$

18. (a) $x \leq -10$

(b) $x \leq -10$

19. (a) $x = -4$

(b) $x = 3, 5$

(c) $x = -1, 7$

20. (a) $(\frac{1}{2}, \frac{1}{3})$

(b) $(1, -2)$

21. (a) –

(b) $y = x^2$

22. (a) $f(2) = 5$
$f(-4) = -1$

(b) x = -1

23. (a) $2x + y = 3$

(b) No solutions

24.

Words	Function Formula
	$f(x) = 2x$
	$f(x) = 5x - 1$
divide the input by 2 and add 5	

25. (a) $f(-3) = 3$
$f(0) = 0$
$f(2) = 2$

(b) $x = \pm 4$

26. (a) –
    (b) 6
    (c) $x = \pm 10$

27. $(3x + 4)(x - 3)$

28. (a) $-7 \leq x$
    (b) $x < 4$

29. (a) 5
    (b) 12
    (c) $|x - y|$

30. No

31. $x \geq 0$

32. $|a - b| = |b - a|$

33. $(4x + 1)(x + 5)$

34. (a) 9 and 4
    (b) 9 and -4
    (c) x and 7
    (d) x and 0

35. (a) –
    (b) $|x| > 6$
    (c) –

36.

–	all values that are 2 units away from -5	–	$x = -3, -7$
$\|x\| = 5\|$	–	–	$x = -5, 5$
$\|x + 1\| = 2$	all values that are 2 units away from -1	–	$x = -3, 1$

37. (a) All values that are 5 units away from 2.
    (b) All values that are 10 units away from -4.

38. $A = (2a + b)(a + 3b)$

39. (a) $(x - 2)(x - 6)$
    (b) $(3x - 2)(2x + 3)$
    (c) $2x(3x - 1)$

40. $BC = 8$, $AC = 15$, and $AB = 17$

41. (a) $x^2 - 16$
    (b) $x^2 - 49$

(c) $9x^2 - 4$

(d) $x^2 - a^2$

42. (a) $(x-8)(x+8)$

(b) $(x-c)(x+c)$

(c) $(2x-5)(2x+5)$

(d) $(ax-c)(ax+c)$

43.

–	all values that are at most 2 units away from -5	–	$-7 \leq x \leq -3$
$\|x\| \geq 6$	–	–	$x < -6$ or $x > 6$
$\|x-1| \leq 4$	all values that are at most 4 units away from 1	–	–

44. (a) –

(b) $(0, 0)$

(c) $(-\infty, \infty)$

(d) $y = 0$

(e) $[0, \infty)$

45. $y = -x$, $y = x$

$$|x| = \begin{cases} -x \text{ if } x < 0 \\ x \text{ if} x \geq 0 \end{cases}$$

46. $x = 12$

47. (a) All values at most 2 units away from 7.

(b) $x > -2$ or $x < -8$

48. $(-2, 2)$
$(3, 7)$

49. (a) –

(b) $|x - 52| \leq 3$

50. $|x - y| = 12$. Infinite.

51. (a) $3x(x+4)$

(b) $(x+5)(x+3)$

(c) $2(x+1)(x-3)$

(d) $9(x-2)(x+2)$

52. 120

53.

$$|x+2| = \begin{cases} -x+2 \text{ if } x < -2 \\ x+2 \text{ if } x \geq -2 \end{cases}$$

54. (a) $x = -5, 5$
    (b) blob $= -5, 5$

55. Yes

56. $f(x) = |x|$

57. (a) 77 blocks
    (b) 19 blocks
    (c) –
    (d) $y = |x - 91|$

58. –

59. $|l - 12| \leq 0.01$

60. (a) $(-28, 12)$
    (b) $(-\infty, 0] \cup [8, \infty)$

61. (a) $a = -1, -6$
    (b) $x = \frac{-19}{2}, \frac{9}{2}$

62. $-1 \leq a \leq 6$

63. $|x| = 3$
    $x = -3$ or $x = 3$

64. No

65. (a) –
    (b) $y = |x - 34|$
    (c) $x = 18, 50$

66. $x = -4, 4$

67. (a) –
    (b) vertex: $(4, 0)$
    domain: $(-\infty, \infty)$
    range: $[0, \infty)$
    minimum value: $y = 0$
    (c) $x = 4$

68. (a) Shift $f(x)$ left by 5
    (b) $(-5, 0)$. Shift it left by 5.

69. $x = 6, 1$

70.
$$|x-7| = \begin{cases} x-7 \text{ if } x \geq 7 \\ -x+7 \text{ if } x < 7 \end{cases}$$

71. $(10, 3)$

72. $x = 4, -6$

73. $x = -1, -4$

74. Shift it right by 3

75. $g(x) = |x - h|$

76.

x	$\lvert x\rvert$	$\lvert x\rvert - 2$
-3	3	1
-2	2	0
-1	1	-1
0	0	-2
1	1	-1
2	2	0
3	3	1

Translate $f(x)$ down by 2.

77. (a) $(-\frac{4}{3}, \frac{4}{3})$
(b) $(-\infty, -\frac{84}{5}] \cup [\frac{56}{5}, \infty)$
(c) $[-\frac{1}{2}, \frac{13}{2}]$

78. (a) $x = -5, -4$
(b) $x = -\frac{7}{2}, 3$
(c) $x = -9, 9$
(d) $x = -\frac{1}{4}, 4$

79. Left graph: $y = |x|$
Right graph: $y = |x - 3|$

80. Shift/translate the graph up by 3
Shift/translate the graph down by 5.

81. $f(x) = |x - 3|$

82. n^2

83. $x = -2, 4$
$x \in [-2, 4]$

84. (a) Shift/translate the graph up by k

(b) $(0, k)$
Shift/translate $(0, 0)$ up by k

85.

x	$\lvert x\rvert$	$-\lvert x\rvert$
-3	3	-3
-2	2	-2
-1	1	-1
0	0	0
1	1	-1
2	2	-2
3	3	-3

You can reflect $y = |x|$ over the x-axis.

86. $(2, 0)$; $(-2, 0), (2, 0)$

87.
$$g(x) = \begin{cases} -x - 2 \text{ if } x \leq 0 \\ x - 2 \text{ if } x > 0 \end{cases}$$

88. Shift $f(x)$ to the right h and up k. Vertex: (h, k).

89.

x	$\lvert x\rvert$	$2\lvert x\rvert$	$0.5\lvert x\rvert$
-3	3	6	1.5
-2	2	4	1
-1	1	2	0.5
0	0	0	0
1	1	2	0.5
2	2	4	1
3	3	6	1.5

You can vertically stretch $|x|$ by a factor of 2 to get $2|x|$. You can vertically compress $|x|$ by a factor of 2 to get $0.5|x|$.

90. (a) Vertically stretch $|x|$ by a factor of a.
(b) Vertically stretch $|x|$ by a factor of a and then reflect it over the x-axis.

91. 320, 210

92. $\begin{bmatrix} 320 & 98 & 135 \\ 405 & 110 & 120 \end{bmatrix}$

93. $(0, |h| + k)$

94. Vertex: $(0, 0)$
Vertex: $(0, 6)$. x-intercepts: $(-2, 0), (2, 0)$

95. (a) Shift $|x|$ right by 1. Vertically stretch it by a factor of 2. Shift it down by 6.

(b) –

(c) Vertex: $(1, -6)$
Domain: $(-\infty, \infty)$
Range: $[-6, \infty)$
Minimum-value: $y = -6$

(d) $(-2, 0), (4, 0)$

96. (a) Shift $f(x)$ right by 3. Reflect it over the x-axis. Shift it up by 5.

(b) –

(c) Vertex: $(3, 5)$
Domain: $(-\infty, \infty)$
Range: $(-\infty, 5]$
Maximum value: 5

(d) $(-2, 0), (8, 0)$

97. $a = -3$

98.

x	$\lvert x \rvert$	x^2
-2	2	4
-1	1	1
$-\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$
1	1	1
2	2	4

Vertex: $(0, 0)$
Domain: $(-\infty, \infty)$
Range: $[0, \infty)$
Minimum value: 0
Axis of symmetry: $x = 0$

99. (a) $y = |x - 1| + 2$

(b) $y = -|x| + 1$

(c) $y = 2|x + 3| - 1$

100. $A + B = \begin{bmatrix} -1 & 3 \\ 6 & -2 \end{bmatrix} + \begin{bmatrix} 7 & 0 \\ 2 & -4 \end{bmatrix} = \begin{bmatrix} 6 & 3 \\ 8 & -6 \end{bmatrix}$

$A - B = \begin{bmatrix} -1 & 3 \\ 6 & -2 \end{bmatrix} - \begin{bmatrix} 7 & 0 \\ 2 & -4 \end{bmatrix} = \begin{bmatrix} -8 & 3 \\ 4 & 2 \end{bmatrix}$

101. Vertex: $(5, -3)$
Domain: $(-\infty, \infty)$
Range: $[-3, \infty)$
Minimum: -3
x-intercepts: $(\frac{1}{2}, 0), (\frac{19}{2}, 0)$

$$y = \begin{cases} \frac{2}{3}(x-5) - 3, & x \geq 5 \\ -\frac{2}{3}(x-5) - 3 & x < 5 \end{cases}$$

102. Two: $(0, h-k), (0, h+k)$

103.

x	x^2	x^2+1	x^2-5
-2	4	5	-1
-1	1	2	-4
0	0	1	-5
1	1	2	-4
2	4	5	-1

$g(x)$: shift $f(x)$ up by 1
$f(x)$: shift $f(x)$ down by 5

104. (a) 3
(b) -9

105. Intersections: $(1, 2), (5, 2)$
$Area = 8$

106. (a) $x = -1, 5$
(b) $(-\infty, -1] \cup [5, \infty)$

107. (a) $[0, 100]$
(b) The midpoint of the road between Salina and Green River
(c) $y = -|x - 50| + 50$
(d) $d = -\frac{5}{6}|t - 60| + 50$

108.

x	x^2	$-x^2$
-3	9	-9
-2	4	-4
-1	1	-1
0	0	0
1	1	-1
2	4	-4

Reflect $f(x)$ over the x-axis.

109.

x	x^2	$2x^2$	$0.5x^2$
-3	9	18	4.5
-2	4	8	2
-1	1	2	0.5
0	0	0	0
1	1	2	0.5
2	4	8	2

$g(x)$: Vertically stretch $f(x)$ by a factor of 2.
$h(x)$: Vertically compress $f(x)$ by a factor of 2.

110. (a) Friday: \$2,250
Saturday: \$7,100
Sunday: \$5,650

(b) $[120, 210] \cdot [10, 5] = 120(10) + 210(5) = \$2,250$

111. Shift $f(x)$ up by c.
Vertex: $(0, c)$
Range: $[c, \infty)$
Minimum: c

112. (a) –

(b) $(32, 55)$

(c) $(21, 55]$

(d) $[45, 65]$

113. Vertically stretch the graph by a factor of 3.
Shift it up by 6.

114. (a)

x	x^2
-3	9
-2	4
-1	1
0	0
1	1
2	4
3	9

x	$\sqrt{x}$
0	0
1	1
4	2
9	3
16	4

The values of x^2 are useful as inputs for the $g(x) = \sqrt{x}$ table.

(b) Vertex: None
Domain: $[0, \infty)$
Range: $[0, \infty)$
Min: 0
It does not have an axis of symmetry.

115. $a = \frac{3}{2}$

116. It's the total revenue that the zoo made on Sunday.

117.
$$\begin{bmatrix} 120(10) + 210(5) \\ 400(10) + 620(5) \\ 320(10) + 490(5) \end{bmatrix} = \begin{bmatrix} 2,250 \\ 7,100 \\ 5,650 \end{bmatrix}$$

118. Vertex: $(0, 0)$
Max: 64
Axis of symmetry: $x = 0$
x-intercepts: $(-4, 0), (0, 4)$

119. Skip

120. Highest: $y = x^2 + 1$
Middle: $y = \frac{1}{2}x^2$
Lowest: $y = -x^2 - 2$

121. Shift the graph right by h

122. Shift $f(x)$ right by 3
Domain of f: $[0, \infty)$
Domain of g: $[3, \infty)$

123.
$$\begin{bmatrix} 16 \\ 20 \end{bmatrix}$$

124.
$$\begin{bmatrix} 5x - 2y \\ 3x + 4y \end{bmatrix}$$

125. No. The number of columns in A must equal the number of rows in B.

126. (a) $(1, 9), (7, 9)$
(b) $x = 1, 7$

127. –

128. –

129. $h(x) = -2(x + 2)^2$

130. $x = -2$
$(-4, 4)$

131. (a) $(x + 5)(x + 5) = (x + 5)^2$, $5 = \frac{10}{2}, \sqrt{25}$
(b) $(x + 6)(x + 6) = (x + 6)^2$, $6 = \frac{12}{2}, \sqrt{36}$
(c) $(x - 7)(x - 7) = (x - 7)^2$, $-7 = \frac{-14}{2}, -\sqrt{49}$

132.
$$\begin{bmatrix} 1 & 6 \\ -7 & -3 \end{bmatrix}$$

133. (a) Shift $f(x)$ down by 4.
(b) $h(x) = -(x + 2)^2 - 7$

134. (a) $x = 1, 4$
(b) $(1, 3), (4, 6)$
(c) –

135. Domain: $[4, \infty)$
Range: $[3, \infty)$

136. $a = -\frac{1}{2}$

137. –

138. $(-\frac{4}{3}, \frac{7}{3}), (\frac{8}{3}, -\frac{1}{3})$

139. (a) $x^2 - 16x + 64 = (x - 8)^2$
(b) $x^2 + 10x + 25 = (x + 5)^2$
(c) $x^2 - 5x + \frac{25}{4} = (x - \frac{5}{2})^2$

140. $(-4, 0), (2, 0)$

141. (a) $2x(x - 4)(x + 4)$
(b) $(x + 12)^2$
(c) $(3x + 1)(3x - 2)$

142. Sum: $\begin{bmatrix} 8 & -2 \\ 1 & 2 \end{bmatrix}$
Product: $\begin{bmatrix} 12 & 2 \\ 2 & -3 \end{bmatrix}$

143. $(5, 0), (0, 1)$

144. Domain: $(-\infty, 0]$
Range: $[0, \infty)$

145. –

146. (a) $x = 3 \pm \sqrt{11}$
(b) $x = 3 \pm \sqrt{11}$
(c) $x = 3 \pm \sqrt{11}$

147. $x = 2 \pm \sqrt{6}$

148. No

149. $$\begin{bmatrix} 1 & 2 \\ 3 & 3 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 5 \\ 6 \end{bmatrix}$$

150. (a) $x = 0, 10$

(b) A.O.S.: $x = 5$
Vertex: $(5, -25)$

(c) –

151. $x = 5$

152. (a) $(0,0), (0,4), (-2,-4)$
(b) $(0,0), (3,0), (\frac{3}{2}, -\frac{9}{2})$
(c) $(0,0), (-\frac{7}{2}, 0), (-\frac{7}{4}, \frac{49}{8})$

153. $x = h \pm \sqrt{-\frac{k}{a}}$

154. (a) $x = 4 \pm \sqrt{19}$

155. $x = -\frac{3}{5} \pm \sqrt{\frac{14}{25}}$

156. $(\frac{48}{13}, \frac{32}{13})$

157. $(\frac{96}{13}, \frac{40}{13})$

158. $(4, -1)$

159. (a) $(2, 3)$
(b) $t = \frac{37}{18}$
(c) The value of t at which P_t intersects $4x + 3y = 18$.
(d) $(\frac{13}{6}, \frac{28}{9})$
(e) $(-\frac{5}{2}, 0)$

160. –