Chapter 5 **Quadratic Relations II**

Chapter 5 Prerequisite Skills

Chapter 5 Prerequisite Skills **Question 1 Page 232**

a) $18x$

b) $135x$

c) $-88x$

d) $4.5x$

Chapter 5 Prerequisite Skills **Question 2 Page 232**

a) $4x^2 - 3x + 9x^2 + 7x$
$= 4x^2 + 9x^2 - 3x + 7x$
$= 13x^2 + 4x$

b) $3x + 2 - 5x + 15$
$= 3x - 5x + 2 + 15$
$= -2x + 17$

c) $10x^2 - 12x - 7x + 9$
$= 10x^2 - 19x + 9$

d) $5x^2 - 3x + 5 - 7x^2 + 4x - 10$
$= 5x^2 - 7x^2 - 3x + 4x + 5 - 10$
$= -2x^2 + x - 5$

Chapter 5 Prerequisite Skills **Question 3 Page 232**

a) $4x + 64$

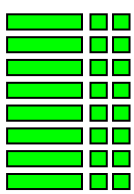
b) $51x + 6x^2$

c) $-84x^2 + 21x$

d) $40x^2 - 50x$

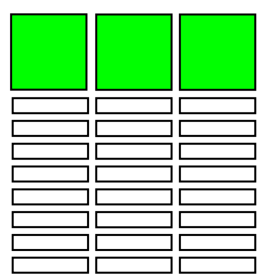
Chapter 5 Prerequisite Skills **Question 4 Page 232**

a)



$8(x + 2) = 8x + 16$

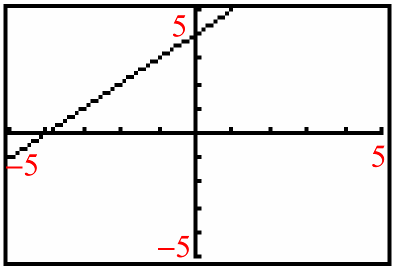
b)



$3x(x - 8) = 3x^2 - 24x$

Chapter 5 Prerequisite Skills **Question 5 Page 232**

a)



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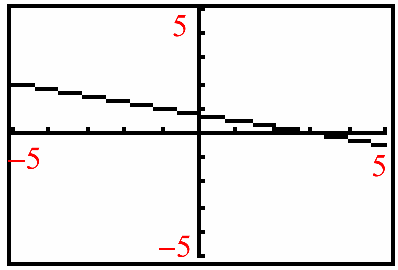

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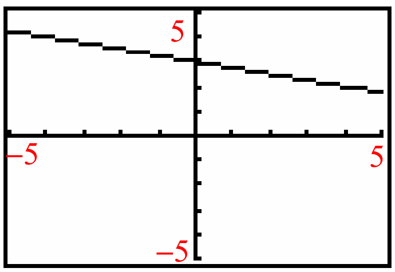
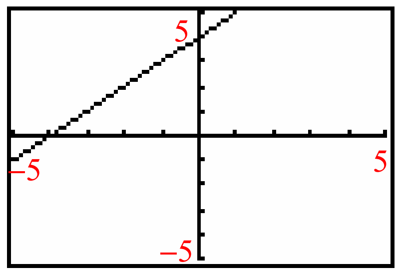


d)



Chapter 5 Prerequisite Skills **Question 6 Page 232**

a) and d)

Chapter 5 Prerequisite Skills **Question 7 Page 233**

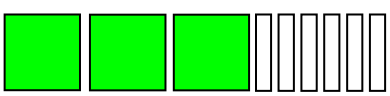
a) x-intercept: –1.5; y-intercept: 4

b) x-intercept: –1 and 5; y-intercept: –5

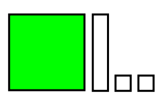
c) x-intercept: 0 and 6; y-intercept: 0

Chapter 5 Prerequisite Skills **Question 8 Page 233**

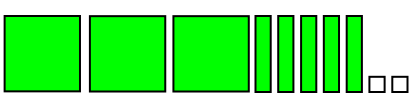
a)



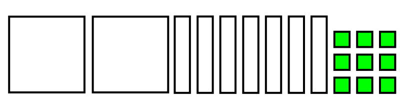
b)



c)



d)



Chapter 5 Prerequisite Skills **Question 9 Page 233**

a) $(-4)^2 - 6(-4) = 16 + 24 = 40$

b) $(-4)^2 - (-4) - 2 = 16 + 4 - 2 = 18$

c) $3(-4)^2 + 5(-4) - 2 = 3(16) - 20 - 2 = 48 - 20 - 2 = 26$

d) $-2(-4)^2 - 7(-4) + 15 = -2(16) + 28 + 15 = -32 + 28 + 15 = 11$

Chapter 5 Prerequisite Skills **Question 10 Page 233**

a) 1, 2, 3, 4, 6, 8, 12, 24

b) 1, 3, 9, 27, 81

c) 1, 2, 3, 5, 6, 10, 15, 30

d) 1, 2, 3, 6, 9, 18, –1, –2, –3, –6, –9, –18

Chapter 5 Prerequisite Skills **Question 11 Page 233**

a) 3 and 7

b) 2 and 6

c) 2 and 10

d) 2 and 16

e) 2 and 25

f) 5 and –4

g) 8 and –8

h) –16 and 4

Chapter 5 Prerequisite Skills **Question 12 Page 233**

a)

$$\begin{aligned} 3x &= 15 \\ x &= \frac{15}{3} \\ x &= 5 \end{aligned}$$

b)

$$\begin{aligned} 17 &= x + 4 \\ 17 - 4 &= x \\ x &= 13 \end{aligned}$$

c)

$$\begin{aligned} x - 15 &= 22 \\ x &= 22 + 15 \\ x &= 37 \end{aligned}$$

d)

$$\begin{aligned} -5x &= 65 \\ x &= \frac{65}{-5} \\ x &= -13 \end{aligned}$$

e)

$$\begin{aligned} 4x - 7 &= 21 \\ 4x &= 21 + 7 \\ 4x &= 28 \\ x &= \frac{28}{4} \\ x &= 7 \end{aligned}$$

f)

$$\begin{aligned} -9x + 22 &= -50 \\ -9x &= -50 - 22 \\ -9x &= -72 \\ x &= \frac{-72}{-9} \\ x &= 8 \end{aligned}$$

g)

$$\begin{aligned} 5x + 15 &= 2x \\ 5x - 2x &= -15 \\ 3x &= -15 \\ x &= \frac{-15}{3} \\ x &= -5 \end{aligned}$$

h)

$$\begin{aligned} -9x &= 6x + 30 \\ -9x - 6x &= 30 \\ -15x &= 30 \\ x &= \frac{30}{-15} \\ x &= -2 \end{aligned}$$

Chapter 5 Prerequisite Skills **Question 13 Page 233**

a) GCF = 3; factored form is $3(x + 3)$

b) GCF = 5; factored form is $5(x + 4)$

c) GCF = 7; factored form is $7(x - 5)$

d) GCF = –8; factored form is $-8(x + 6)$

e) GCF = x; factored form is $x(x - 4)$

f) GCF = $4x$; factored form is $4x(x + 6)$

g) GCF = $-3x$; factored form is $-3x(5x - 9)$

h) GCF = 5; factored form is $5(4x^2 - 11)$

Chapter 5 Prerequisite Skills Question 14 Page 233

a) $(x + 1)(x + 2)$ (Find 2 numbers that add to 3 and multiply to 2.)

b) $(x + 3)(x – 2)$ (Find 2 numbers that add to 1 and multiply to –6.)

c) $(x – 2)(x – 6)$ (Find 2 numbers that add to –8 and multiply to 12.)

d) $(x + 2)(x + 7)$ (Find 2 numbers that add to 9 and multiply to 14.)

e) $(x – 5)(x + 2)$ (Find 2 numbers that add to –3 and multiply to –10.)

f) $(x – 1)(x – 1)$ or $(x – 1)^2$ (Find 2 numbers that add to –2 and multiply to 1.)

Chapter 5 Section 1 **Expand Binomials**

Chapter 5 Section 1 **Question 1 Page 238**

a) width = 2 ; length = $(x + 2)$

b) width = $(x + 1)$; length = $(x + 2)$

c) width = $(2x + 1)$; length = $(x + 2)$

d) width = $(2x + 1)$; length = $(3x + 4)$

Chapter 5 Section 1 **Question 2 Page 238**

a) $2(x + 2) = 2x + 4$

b) $(x + 1)(x + 2) = x^2 + 3x + 2$

c) $(2x + 1)(x + 2) = 2x^2 + 5x + 2$

d) $(2x + 1)(3x + 4) = 6x^2 + 11x + 4$

Chapter 5 Section 1 **Question 3 Page 239**

a) $x^2 + 8x$

b) $x^2 + 1x + 7x + 7 = x^2 + 8x + 7$

c) $x^2 + 4x + 3x + 12 = x^2 + 7x + 12$

d) $2x^2 + 6x + 1x + 3 = 2x^2 + 7x + 3$

e) $24x^2 + 8x + 30x + 10 = 24x^2 + 38x + 10$

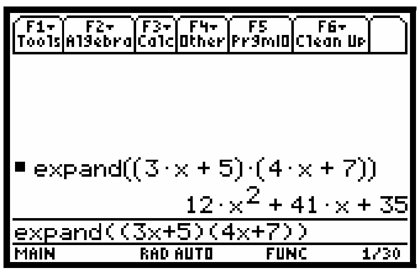
f) $9x^2 + 6x + 6x + 4 = 9x^2 + 12x + 4$

Chapter 5 Section 1 Question 4 Page 239

a) ***Method 1:*** Distributive Property
$(3x + 5)(4x + 7)$
$= (3x + 5)(4x) + (3x + 5)(7)$
$= 12x^2 + 41x + 35$

Method 2: FOIL
$(3x + 5)(4x + 7)$
$= 12x^2 + 21x + 20x + 35$
$= 12x^2 + 41x + 35$

Method 3: CAS



Use FOIL for b) to f).

b) $6x^2 + 24x - 11x - 44 = 6x^2 + 13x - 44$

c) $18x^2 + 90x - 12x - 60 = 18x^2 + 78x - 60$

d) $35x^2 + - 56x + 10x - 16 = 35x^2 - 46x - 16$

e) $9 + 24x - 24x - 64x^2 = 9 - 64x^2$

f) $16x^2 + 36x + 36x + 81 = 16x^2 + 72x + 81$

Chapter 5 Section 1 Question 5 Page 239

Use FOIL.

a) $2x^2 + 20x + 3x + 30 = 2x^2 + 23x + 30$

b) $3x^2 + 15x + 10x + 50 = 3x^2 + 25x + 50$

c) $3x^2 + 11x - 36x - 132 = 3x^2 - 25x - 132$

d) $75 + 10x - 150x - 20x^2 = -20x^2 - 140x + 75$

e) $4x^2 - 60x - 9x + 135 = 4x^2 - 69x + 135$

f) $256x^2 + 144x + 144x + 81 = 256x^2 + 288x + 81$

Chapter 5 Section 1 Question 6 Page 239

Use FOIL.

a) $x^2 + 5x - 5x - 25 = x^2 - 25$

b) $x^2 + 10x - 10x - 100 = x^2 - 100$

c) $9x^2 - 21x + 21x - 49 = 9x^2 - 49$

d) $64x^2 + 40x - 40x - 25 = 64x^2 - 25$

e) $49x^2 + 49x - 49x - 49 = 49x^2 - 49$

f) $144x^2 - 108x + 108x - 81 = 144x^2 - 81$

Chapter 5 Section 1 Question 7 Page 239

Use FOIL.

a) $x^2 + 6x + 6x + 36 = x^2 + 12x + 36$

b) $x^2 - 8x - 8x + 64 = x^2 - 16x + 64$

c) $16x^2 + 60x + 60x + 225 = 16x^2 + 120x + 225$

d) $81x^2 - 18x - 18x + 4 = 81x^2 - 36x + 4$

e) $25x^2 - 15x - 15x + 9 = 25x^2 - 30x + 9$

f) $36x^2 + 72x + 72x + 144 = 36x^2 + 144x + 144$

Chapter 5 Section 1 Question 8 Page 239

Answers may vary. Patterns are as follows:

$(ax + b)(ax - b) = a^2x^2 - b^2$

$(ax + b)^2 = (ax + b)(ax + b) = a^2x^2 + 2abx + b^2$

$(ax - b)^2 = (ax - b)(ax - b) = a^2x^2 - 2abx + b^2$

Chapter 5 Section 1 Question 9 Page 239

a) i) $(3x + 7)(2x - 2) = 6x^2 - 6x + 14x - 14 = 6x^2 + 8x - 14$

ii) $(x - 2)(5x - 3) = 5x^2 - 3x - 10x + 6 = 5x^2 - 13x + 6$

iii) $(2x - 11)(6x + 5) = 12x^2 + 10x - 66x - 55 = 12x^2 - 56x - 55$

b) i) $6(12)^2 + 8(12) - 14 = 864 + 96 - 14 = 946$

The area is 946 cm^2.

ii) $5(12)^2 - 13(12) + 6 = 720 - 156 + 6 = 570$

The area is 570 cm^2.

iii) $12(12)^2 - 56(12) - 55 = 1728 - 672 - 55 = 1001$

The area is 1001 cm^2.

Chapter 5 Section 1 Question 10 Page 240

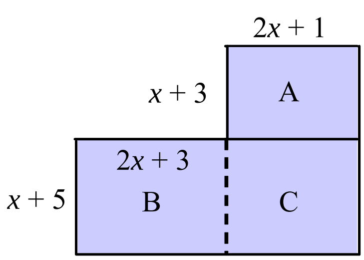
a) $(s + 6)(2s - 5)$
$= 2s^2 - 5s + 12s - 30$
$= 2s^2 + 7s - 30$

b) $2(10)^2 + 7(10) - 30$
$= 200 + 70 - 30$
$= 240$

The area is 240 m^2.

Chapter 5 Section 1 Question 11 Page 240

Divide the shape into three rectangles of these dimensions:



Area of A: $(x + 3)(2x + 1)$
Area of B: $(x + 5)(2x + 3)$
Area of C: $(x + 5)(2x + 1)$
Area $= (x + 3)(2x + 1) + (x + 5)(2x + 3) + (x + 5)(2x + 1)$
$= 2x^2 + 1x + 6x + 3 + 2x^2 + 3x + 10x + 15 + 2x^2 + 1x + 10x + 5$
$= 6x^2 + 31x + 23$

Chapter 5 Section 1 Question 12 Page 240

a) Area of the base of the fountain:
$(3x + 5)(2x + 3)$
$= 6x^2 + 9x + 10x + 15$
$= 6x^2 + 19x + 15$

b) $6(3)^2 + 19(3) + 15 = 54 + 57 + 15 = 126$
When $x = 3$, the area is 126 m^2.
The minimum area of the base is 15 m^2.

The difference between the two areas is: 126 m^2 – 15 m^2 = 111 m^2

c) For the smallest fountain:
Cost = \$900/m^2 × 15 m^2 = \$13 500

For the largest fountain:
Cost = \$900/m^2 × 126 m^2 = \$113 400

Chapter 5 Section 1 Question 13 Page 240

a) Equate the two ratios.

$$\begin{aligned} \frac{3x+5}{2x+3} &= \frac{1.618}{1} \\ 1.618(2x+3) &= 3x+5 \\ 3.236x+4.854 &= 3x+5 \\ 0.236x &= 0.146 \\ x &= \frac{0.146}{0.236} \\ x &\doteq 0.62 \end{aligned}$$

The value of x when the base is a golden rectangle is about 0.62.

b) Answers will vary.

Chapter 5 Section 1 Question 14 Page 241

Area of the shape:
$(6x + 5)(8x – 3) – (2x + 4)(x – 5)$
$= (48x^2 – 18x + 40x – 15) – (2x^2 – 10x + 4x – 20)$
$= 48x^2 – 18x + 40x – 15 – 2x^2 + 10x – 4x + 20$
$= 46x^2 + 28x + 5$

Chapter 5 Section 1 Question 15 Page 241

a) Think of the cardboard as a large rectangle of dimensions (x + 20 + x) by (x + 12 + x) with 4 small squares of dimensions x by x removed.
The area of cardboard is:

$$(2x+20)(2x+12)-4x^2$$
$$=4x^2+24x+40x+240-4x^2$$
$$=64x+240$$

b) Substitute $x = 3$, $x = 5$, and $x = 10$ in the expression $64x + 240$.

64(3) + 240 = 432
If the height of the box is 3 cm, the area of the box is 432 cm^2.

64(5) + 240 = 560
If the height of the box is 5 cm, the area of the box is 560 cm^2.

64(10) + 240 = 880
If the height of the box is 10 cm, the area of the box is 880 cm^2.

c) For a height of 3 cm, the cost is: $\frac{5¢}{100\text{ cm}^2} \times 432\text{ cm}^2 = 21.6¢$

For a height of 5 cm, the cost is: $\frac{5¢}{100\text{ cm}^2} \times 560\text{ cm}^2 = 28¢$

For a height of 10 cm, the cost is: $\frac{5¢}{100\text{ cm}^2} \times 880\text{ cm}^2 = 44¢$

Chapter 5 Section 1 Question 16 Page 241

a)

$$(3x+2)(x^2+4x+9)$$
$$=3x^3+12x^2+27x+2x^2+8x+18$$
$$=3x^3+14x^2+35x+18$$

b)

$$(2x-5)(7x^2-2x+8)$$
$$=14x^3-4x^2+16x-35x^2+10x-40$$
$$=14x^3-39x^2+26x-40$$

c)

$$(x^2+10x+1)(x^2-3x+11)$$
$$=x^4-3x^3+11x^2+10x^3-30x^2+110x+x^2-3x+11$$
$$=x^4+7x^3-18x^2+107x+11$$

Chapter 5 Section 1 Question 17 Page 241

a) $(x + 5)(x + 5)$

b) $(x - 9)(x - 9)$

c) $(x + 12)(x + 12)$

d) $(x + 6)(x - 6)$

e) $(x + 8)(x - 8)$

f) $(x + 11)(x - 11)$

Chapter 5 Section 2 **Change Quadratic Relations From Vertex Form to Standard Form**

Chapter 5 Section 2 **Question 1 Page 245**

a)

$$\begin{aligned} y &= (x+6)^2 \\ &= (x+6)(x+6) \\ &= x^2+6x+6x+36 \\ &= x^2+12x+36 \end{aligned}$$

In standard form: $y = x^2 + 12x + 36$

b)

$$\begin{aligned} y &= (x-4)^2 \\ &= (x-4)(x-4) \\ &= x^2-4x-4x+16 \\ &= x^2-8x+16 \end{aligned}$$

In standard form: $y = x^2 - 8x + 16$

c)

$$\begin{aligned} y &= (x-15)^2 \\ &= (x-15)(x-15) \\ &= x^2-15x-15x+225 \\ &= x^2-30x+225 \end{aligned}$$

In standard form: $y = x^2 - 30x + 225$

d)

$$\begin{aligned} y &= (x-2)^2 \\ &= (x-2)(x-2) \\ &= x^2-2x-2x+4 \\ &= x^2-4x+4 \end{aligned}$$

In standard form: $y = x^2 - 4x + 4$

e)

$$\begin{aligned} y &= (x+9)^2 \\ &= (x+9)(x+9) \\ &= x^2+9x+9x+81 \\ &= x^2+18x+81 \end{aligned}$$

In standard form: $y = x^2 + 18x + 81$

f)

$$\begin{aligned} y &= (x-1)^2 \\ &= (x-1)(x-1) \\ &= x^2-1x-1x+1 \\ &= x^2-2x+1 \end{aligned}$$

In standard form: $y = x^2 - 2x + 1$

Chapter 5 Section 2 **Question 2 Page 245**

a)

$$\begin{aligned} y &= 3(x+9)^2 \\ &= 3(x+9)(x+9) \\ &= 3(x^2+9x+9x+81) \\ &= 3(x^2+18x+81) \\ &= 3x^2+54x+243 \end{aligned}$$

In standard form: $y = 3x^2+54x+243$

b)

$$\begin{aligned} y &= -2(x+7)^2 \\ &= -2(x+7)(x+7) \\ &= -2(x^2+7x+7x+49) \\ &= -2(x^2+14x+49) \\ &= -2x^2-28x-98 \end{aligned}$$

In standard form: $y = -2x^2-28x-98$

c)

$$\begin{aligned} y &= -8(x-5)^2 \\ &= -8(x-5)(x-5) \\ &= -8(x^2-5x-5x+25) \\ &= -8(x^2-10x+25) \\ &= -8x^2+80x-200 \end{aligned}$$

In standard form: $y = -8x^2+80x-200$

d)

$$\begin{aligned} y &= 0.5(x+2)^2 \\ &= 0.5(x+2)(x+2) \\ &= 0.5(x^2+2x+2x+4) \\ &= 0.5(x^2+4x+4) \\ &= 0.5x^2+2x+2 \end{aligned}$$

In standard form: $y = 0.5x^2+2x+2$

e)

$$\begin{aligned} y &= -0.25(x+8)^2 \\ &= -0.25(x+8)(x+8) \\ &= -0.25(x^2+8x+8x+64) \\ &= -0.25(x^2+16x+64) \\ &= -0.25x^2-4x-16 \end{aligned}$$

In standard form: $y = -0.25x^2-4x-16$

f)

$$\begin{aligned} y &= 9.8(x-3.2)^2 \\ &= 9.8(x-3.2)(x-3.2) \\ &= 9.8(x^2-3.2x-3.2x+10.24) \\ &= 9.8(x^2-6.4x+10.24) \\ &= 9.8x^2-62.72x+100.352 \end{aligned}$$

In standard form: $y = 9.8x^2-62.72x+100.352$

Chapter 5 Section 2 **Question 3 Page 245**

a)

$$\begin{aligned} y &= (x-8)^2 + 3 \\ &= (x-8)(x-8) + 3 \\ &= x^2 - 8x - 8x + 64 + 3 \\ &= x^2 - 16x + 67 \end{aligned}$$

In standard form: $y = x^2 - 16x + 67$

b)

$$\begin{aligned} y &= (x+5)^2 + 10 \\ &= (x+5)(x+5) + 10 \\ &= x^2 + 5x + 5x + 25 + 10 \\ &= x^2 + 10x + 35 \end{aligned}$$

In standard form: $y = x^2 + 10x + 35$

c)

$$\begin{aligned} y &= (x+1)^2 - 13 \\ &= (x+1)(x+1) - 13 \\ &= x^2 + 1x + 1x + 1 - 13 \\ &= x^2 + 2x - 12 \end{aligned}$$

In standard form: $y = x^2 + 2x - 12$

d)

$$\begin{aligned} y &= (x-3)^2 + 1 \\ &= (x-3)(x-3) + 1 \\ &= x^2 - 3x - 3x + 9 + 1 \\ &= x^2 - 6x + 10 \end{aligned}$$

In standard form: $y = x^2 - 6x + 10$

e)

$$\begin{aligned} y &= (x+6)^2 - 7 \\ &= (x+6)(x+6) - 7 \\ &= x^2 + 6x + 6x + 36 - 7 \\ &= x^2 + 12x + 29 \end{aligned}$$

In standard form: $y = x^2 + 12x + 29$

f)

$$\begin{aligned} y &= (x-5)^2 - 3 \\ &= (x-5)(x-5) - 3 \\ &= x^2 - 5x - 5x + 25 - 3 \\ &= x^2 - 10x + 22 \end{aligned}$$

In standard form: $y = x^2 - 10x + 22$

Chapter 5 Section 2 **Question 4 Page 245**

a)

$$\begin{aligned} y &= 5(x-4)^2+12 \\ &= 5(x-4)(x-4)+12 \\ &= 5(x^2-4x-4x+16)+12 \\ &= 5(x^2-8x+16)+12 \\ &= 5x^2-40x+80+12 \\ &= 5x^2-40x+92 \end{aligned}$$

In standard form: $y = 5x^2 - 40x + 92$

b)

$$\begin{aligned} y &= -6(x+9)^2-7 \\ &= -6(x+9)(x+9)-7 \\ &= -6(x^2+9x+9x+81)-7 \\ &= -6(x^2+18x+81)-7 \\ &= -6x^2-108x-486-7 \\ &= -6x^2-108x-493 \end{aligned}$$

In standard form: $y = -6x^2 - 108x - 493$

c)

$$\begin{aligned} y &= -2(x+7)^2-10 \\ &= -2(x+7)(x+7)-10 \\ &= -2(x^2+7x+7x+49)-10 \\ &= -2(x^2+14x+49)-10 \\ &= -2x^2-28x-98-10 \\ &= -2x^2-28x-108 \end{aligned}$$

In standard form: $y = -2x^2 - 28x - 108$

d)

$$\begin{aligned} y &= -8(x-5)^2+6 \\ &= -8(x-5)(x-5)+6 \\ &= -8(x^2-5x-5x+25)+6 \\ &= -8(x^2-10x+25)+6 \\ &= -8x^2+80x-200+6 \\ &= -8x^2+80x-194 \end{aligned}$$

In standard form: $y = -8x^2 + 80x - 194$

e)

$$\begin{aligned} y &= 2.4(x-5.1)^2+6 \\ &= 2.4(x-5.1)(x-5.1)+6 \\ &= 2.4(x^2-5.1x-5.1x+26.01)+6 \\ &= 2.4(x^2-10.2x+26.01)+6 \\ &= 2.4x^2-24.48x+62.424+6 \\ &= 2.4x^2-24.48x+68.424 \end{aligned}$$

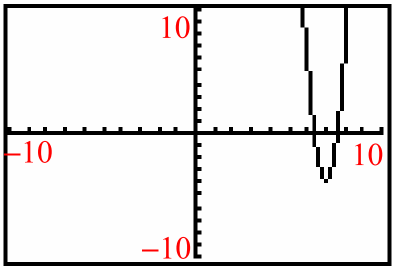
In standard form:
$y = 2.4x^2 - 24.48x + 68.424$

f)

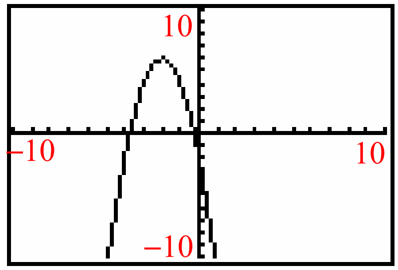
$$\begin{aligned} y &= -1.9(x+2.7)^2-5.1 \\ &= -1.9(x+2.7)(x+2.7)-5.1 \\ &= -1.9(x^2+2.7x+2.7x+7.29)-5.1 \\ &= -1.9(x^2+5.4x+7.29)-5.1 \\ &= -1.9x^2-10.26x-13.851-5.1 \\ &= -1.9x^2-10.26x-18.951 \end{aligned}$$

In standard form:
$y = -1.9x^2 - 10.26x - 18.951$

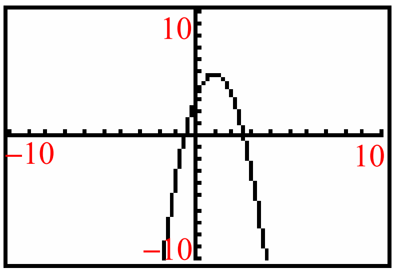
a)



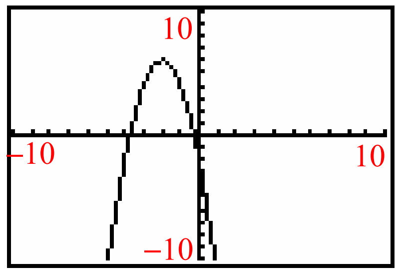
b)



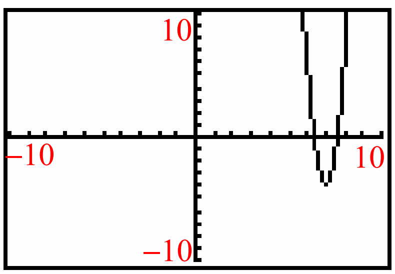
c)



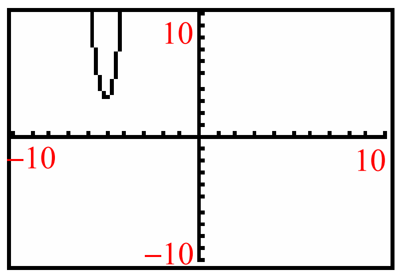
d)



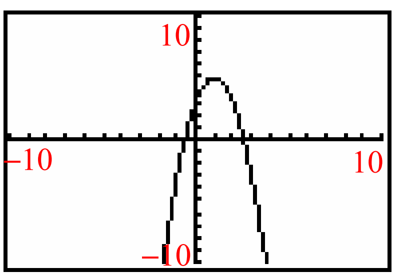
e)



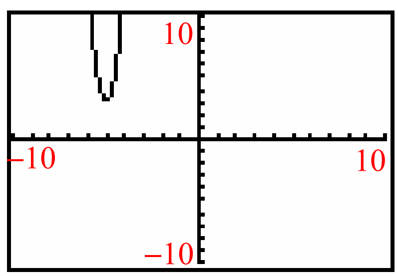
f)



g)



h)



a) and e) are the same; b) and d) are the same; c) and g) are the same; f) and h) are the same.

Chapter 5 Section 2 Question 6 Page 245

a) Equation in vertex form is $y = 5(x - 1)^2 + 7$.
Expanding and simplifying,
$y = 5(x - 1)(x - 1) + 7$
$y = 5(x^2 - 1x - 1x + 1) + 7$
$y = 5(x^2 - 2x + 1) + 7$
$y = 5x^2 - 10x + 5 + 7$
$y = 5x^2 - 10x + 12$

b) Equation in vertex form is $y = -3(x + 5)^2 + 6$.
Expanding and simplifying,
$y = -3(x + 5)(x + 5) + 6$
$y = -3(x^2 + 5x + 5x + 25) + 6$
$y = -3(x^2 + 10x + 25) + 6$
$y = -3x^2 - 30x - 75 + 6$
$y = -3x^2 - 30x - 69$

c) Equation in vertex form is $y = -8(x - 10)^2 + 17$.
Expanding and simplifying,
$y = -8(x - 10)(x - 10) + 17$
$y = -8(x^2 - 10x - 10x + 100) + 17$
$y = -8(x^2 - 20x + 100) + 17$
$y = -8x^2 + 160x - 800 + 17$
$y = -8x^2 + 160x - 783$

d) Equation in vertex form is $y = 12(x + 1)^2 + 3$.
Expanding and simplifying,
$y = 12(x + 1)(x + 1) + 3$
$y = 12(x^2 + 1x + 1x + 1) + 3$
$y = 12(x^2 + 2x + 1) + 3$
$y = 12x^2 + 24x + 12 + 3$
$y = 12x^2 + 24x + 15$

Chapter 5 Section 2 Question 7 Page 245

The *y*-intercept is found by substituting $x = 0$ in the equation.

a) $y = 3(0+12)^2 + 15 = 3(144) + 15 = 434 + 15 = 447$

b) $y = 10(0)^2 - 15(0) + 7 = 0 - 0 + 7 = 7$

c) $y = -7(0-5)^2 - 6 = -7(25) - 6 = -175 - 6 = -181$

d) $y = 9(0)^2 - 20 = 0 - 20 = -20$

e) $y = 4(0)^2 + 5(0) - 1 = 0 + 0 - 1 = -1$

f) $y = 1.5(0-2.4)^2 + 6.4 = 1.5(5.76) + 6.4 = 8.64 + 6.4 = 15.04$

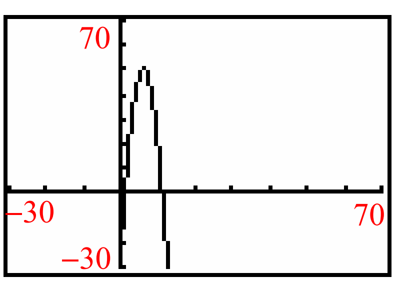
Chapter 5 Section 2 Question 8 Page 246

a) The *v*-coordinate of the vertex is 6.
This is the speed of the racer when the maximum distance is reached.

b) The *d*-coordinate of the vertex is 50.
This is the maximum distance travelled for the best speed 6 m/s.

c) $d = -2(v-6)^2 + 50$
Expanding and simplifying,
$d = -2(v-6)(v-6) + 50$
$d = -2(v - 6v - 6v + 36) + 50$
$d = -2(v - 12v + 36) + 50$
$d = -2v^2 + 24v - 72 + 50$
$d = -2v^2 + 24v - 22$

d)



Chapter 5 Section 2 Question 9 Page 246

a) Answers may vary. For example:
It shows the y-intercept, but it does not provide any information on the maximum or minimum value of the relation.

b) Answers may vary. For example:
It shows the vertex of the graph; but not the x- and y-intercepts.

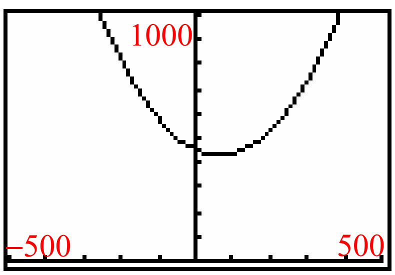
Chapter 5 Section 2 Question 10 Page 246

a) $h = 0.000\ 549(x - 640)^2 + 227$

b) $h = 0.000\ 549\ (x - 640)(x - 640) + 227$
$h = 0.000\ 549\ (x^2 - 640x - 640x + 409\ 600) + 227$
$h = 0.000\ 549\ (x^2 - 1280x + 409\ 600) + 227$
$h = 0.000\ 549v^2 - 0.702\ 72 + 224.8704 + 227$
$h = 0.000\ 549x^2 - 0.702\ 72x + 451.8704$

c) This is the h-intercept. Substitute $x = 0$ in the equation. $h = 451.8704$ m

d)



Chapter 5 Section 2 Question 11 Page 246

a) $y = –4.9(t - 2)^2 + 20$

b) Expanding and simplifying,
$y = –4.9(t - 2)(t - 2) + 20$
$y = –4.9\ (t - 2t - 2t + 4) + 20$
$y = –4.9\ (t - 4t + 4) + 20$
$y = –4.9t^2 + 19.6t - 19.6 + 20$
$y = –4.9t^2 + 19.6t - 0.4$

c) The initial velocity is the coefficient of the t-term in the equation. It is 19.6 m/s.

d) This is the y-coordinate of the vertex (2, 20). It is 20 m.

Chapter 5 Section 2 Question 12 Page 247

Solutions for Achievement Checks are in the *Teacher Resource*.

Chapter 5 Section 2 Question 13 Page 247

a) $a = -\frac{2106}{(36)^2} = -\frac{2106}{1296} = -1.625$

b) The relation in vertex form is $y = -1.625(x - 1.8)^2 + 8.0$.

c) The height of the rider is the same as the height of the ramp when the horizontal distance from the ramp is zero.
Substitute $x = 0$ into the equation.
$y = -1.625(0 - 1.8)^2 + 8.0$
$y = -1.625(3.24) + 8.0$
$y = -5.265 + 8.0$
$y = 2.735$ m

The ramp is 2.735 m high.

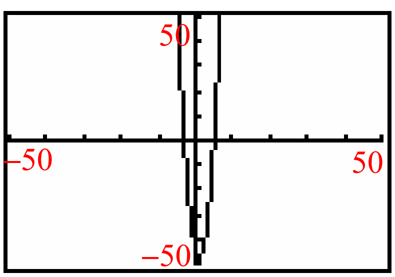
Chapter 5 Section 2 Question 14 Page 247

a) Both equal $3x^2 - 6x - 45$.

$$\begin{aligned} y &= 3(x-1)^2 - 48 \\ &= 3(x-1)(x-1) - 48 \\ &= 3(x^2 - 1x - 1x + 1) - 48 \\ &= 3(x^2 - 2x + 1) - 48 \\ &= 3x^2 - 6x + 3 - 48 \\ &= 3x^2 - 6x - 45 \end{aligned}$$

$$\begin{aligned} y &= 3(x+3)(x-5) \\ &= 3(x^2 - 5x + 3x - 15) \\ &= 3(x^2 - 2x - 15) \\ &= 3x^2 - 6x - 45 \end{aligned}$$

b)



c) Answers may vary. For example:
The numbers in the brackets are the opposites of the *x*-intercepts.

Chapter 5 Section 3 **Factor Trinomials of the Form $x^2 + bx + c$**

Chapter 5 Section 3 **Question 1 Page 253**

a) 5 and 5

b) 4 and 8

c) –2 and –12

d) –2 and –18

e) 6 and –5

f) 3 and –14

g) 25 and –2

h) 8 and –8

Chapter 5 Section 3 **Question 2 Page 253**

a) $(x + 3)(x + 12)$
Checking by expanding:
$(x + 3)(x + 12)$
$= x^2 + 12x + 3x + 36$
$= x^2 + 15x + 36$

b) $(x + 4)(x + 4)$
Checking by expanding:
$(x + 4)(x + 4)$
$= x^2 + 4x + 4x + 16$
$= x^2 + 8x + 16$

c) $(x + 2)(x + 10)$
Checking by expanding:
$(x + 2)(x + 10)$
$= x^2 + 10x + 2x + 20$
$= x^2 + 12x + 20$

d) $(x + 5)(x + 8)$
Checking by expanding:
$(x + 5)(x + 8)$
$= x^2 + 8x + 5x + 40$
$= x^2 + 13x + 40$

Chapter 5 Section 3 Question 3 Page 253

a) Find 2 numbers that multiply to 22 and add to –13.
By trial-and-error, the numbers are –2 and –11.
$x^2 - 13x + 22 = (x - 2)(x - 11)$

b) Find 2 numbers that multiply to 49 and add to –14.
By trial-and-error, the numbers are –7 and –7.
$x^2 - 14x + 49 = (x - 7)(x - 7)$

c) Find 2 numbers that multiply to 28 and add to –11.
By trial-and-error, the numbers are –4 and –7.
$x^2 - 11x + 28 = (x - 4)(x - 7)$

d) Find 2 numbers that multiply to 100 and add to –20.
By trial-and-error, the numbers are –10 and –10.
$x^2 - 20x + 100 = (x - 10)(x - 10)$

e) Find 2 numbers that multiply to –32 and add to 14.
By trial-and-error, the numbers are –2 and 16.
$x^2 + 14x - 32 = (x - 2)(x + 16)$

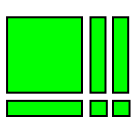
f) Find 2 numbers that multiply to –48 and add to +13.
By trial-and-error, the numbers are –3 and 16.
Factors are $(x - 3)(x + 16)$

g) Find 2 numbers that multiply to –20 and add to –1.
By trial-and-error, the numbers are –5 and 4.
Factors are $(x - 5)(x + 4)$

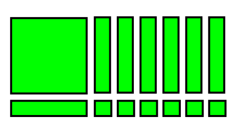
h) Find 2 numbers that multiply to –63 and add to –18.
By trial-and-error, the numbers are –21 and 3.
Factors are $(x - 21)(x + 3)$

Chapter 5 Section 3 Question 4 Page 254

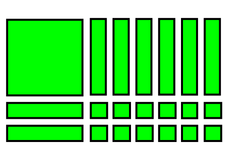
a) $x^2 + 3x + 2 = (x + 1)(x + 2)$



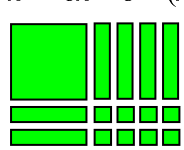
b) $x^2 + 7x + 6 = (x + 1)(x + 6)$



c) $x^2 + 8x + 12 = (x + 2)(x + 6)$



d) $x^2 + 6x + 8 = (x + 2)(x + 4)$



Chapter 5 Section 3 Question 5 Page 254

a) $x^2 + 6x + 8 = (x + 2)(x + 4)$

b) $x^2 + 8x + 7 = (x + 1)(x + 7)$

c) $x^2 + 8x + 15 = (x + 3)(x + 5)$

d) $x^2 + 10x + 24 = (x + 6)(x + 4)$

Chapter 5 Section 3 Question 6 Page 254

Both ***Method 1*** and ***Method 2*** on text page 251 can be used.

a) ***Method 1***

$x^2 + 5x$ can be rewritten as $x^2 + 5x + 0$.
Find 2 numbers that have a sum of 5 and a product of 0.
One of the factors (numbers) must be 0. The numbers are 0 and 5.
$x^2 + 5x = (x + 0)(x + 5) = x(x + 5)$

Method 2

The GCF for x^2 and $5x$ is x.
So, $x^2 + 5x = x(x + 5)$

b) ***Method 1***

$x^2 + 22x$ can be rewritten as $x^2 + 22x + 0$.
Find 2 numbers that have a sum of 22 and a product of 0.
One of the factors (numbers) must be 0. The numbers are 0 and 22.
$x^2 + 22x = (x + 0)(x + 22) = x(x + 22)$

Method 2

The GCF for x^2 and $22x$ is x.
So, $x^2 + 22x = x(x + 22)$

c) ***Method 1***

$x^2 – 19x$ can be rewritten as $x^2 – 19x + 0$.
Find 2 numbers that have a sum of –19 and a product of 0.
One of the factors (numbers) must be 0. The numbers are 0 and –19.
$x^2 – 19x = (x + 0)(x – 19) = x(x – 19)$

Method 2

The GCF for x^2 and $–19x$ is x.
So, $x^2 – 19x = x(x – 19)$

d) ***Method 1***

$x^2 - 15x$ can be rewritten as $x^2 - 15x + 0$.

Find 2 numbers that have a sum of –15 and a product of 0.

One of the factors (numbers) must be 0. The numbers are 0 and –15.

$x^2 - 15x = (x + 0)(x - 15) = x(x - 15)$

Method 2

The GCF for x^2 and $-15x$ is x.

So, $x^2 - 15x = x(x - 15)$

e) ***Method 1***

$x^2 - 9.8x$ can be rewritten as $x^2 - 9.8x + 0$.

Find 2 numbers that have a sum of –9.8 and a product of 0.

One of the factors (numbers) must be 0. The numbers are 0 and –9.8.

$x^2 - 9.8x = (x + 0)(x - 9.8) = x(x - 9.8)$

Method 2

The GCF for x^2 and $-9.8x$ is x.

So, $x^2 - 9.8x = x(x - 9.8)$

f) ***Method 1***

$x^2 + 33.5x$ can be rewritten as $x^2 + 33.5x + 0$.

Find 2 numbers that have a sum of 33.5 and a product of 0.

One of the factors (numbers) must be 0. The numbers are 0 and 33.5.

$x^2 + 33.5x = (x + 0)(x + 33.5) = x(x + 33.5)$

Method 2

The GCF for x^2 and $33.5x$ is x.

So, $x^2 + 33.5x = x(x + 33.5)$

Chapter 5 Section 3 Question 7 Page 254

a) $x^2 - 25$ can be rewritten as $x^2 + 0x - 25$.
Find 2 numbers with product –25 and sum 0. The numbers are 5 and –5.
$x^2 - 25 = (x + 5)(x - 5)$
Check by expanding,
$(x + 5)(x - 5) = x^2 - 5x + 5x - 25 = x^2 - 25$

b) $x^2 - 100$ can be rewritten as $x^2 + 0x - 100$.
Find 2 numbers with product –100 and sum 0. The numbers are 10 and –10.
$x^2 - 100 = (x + 10)(x - 10)$
Check by expanding,
$(x + 10)(x - 10) = x^2 -10x + 10x - 100 = x^2 - 100$

c) $x^2 - 121$ can be rewritten as $x^2 + 0x - 121$.
Find 2 numbers with product –121 and sum 0. The numbers are 11 and –11.
$x^2 - 121 = (x + 11)(x - 11)$
Check by expanding,
$(x + 11)(x - 11) = x^2 - 11x + 11x - 121 = x^2 - 121$

d) $x^2 - 1$ can be rewritten as $x^2 + 0x - 1$.
Find 2 numbers with product –1 and sum 0. The numbers are 1 and –1.
$x^2 - 1 = (x + 1)(x - 1)$
Check by expanding,
$(x + 1)(x - 1) = x^2 - 1x + 1x - 1 = x^2 - 1$

e) $x^2 - 49$ can be rewritten as $x^2 + 0x - 49$.
Find 2 numbers with product –49 and sum 0. The numbers are 7 and –7.
$x^2 - 49 = (x + 7)(x - 7)$
Check by expanding,
$(x + 7)(x - 7) = x^2 - 7x + 7x - 49 = x^2 - 49$

f) $x^2 - 144$ can be rewritten as $x^2 + 0x - 144$.
Find 2 numbers with product –144 and sum 0. The numbers are 12 and –12.
$x^2 - 144 = (x + 12)(x - 12)$
Check by expanding,
$(x + 12)(x - 12) = x^2 - 12x + 12x - 144 = x^2 - 144$

Chapter 5 Section 3 Question 8 Page 254

a) The GCF for x^2 and $25x$ is x.
So, $x^2 + 25x = x(x + 25)$

b) Find 2 numbers with product of 28 and sum 16. The numbers are 2 and 14.
$x^2 + 16x + 28 = (x + 2)(x + 14)$

c) Find 2 numbers with product –42 and sum –1. The numbers are 6 and –7.
$x^2 - x - 42 = (x + 6)(x - 7)$

d) $x^2 - 64$ can be rewritten as $x^2 + 0x - 64$.
Find 2 numbers with product –64 and sum 0. The numbers are 8 and –8.
$x^2 - 64 = (x + 8)(x - 8)$

e) Find 2 numbers with product 36 and sum 13. The numbers are 4 and 9.
$x^2 + 13x + 36 = (x + 4)(x + 9)$

f) Find 2 numbers with product 36 and sum –12. The numbers are –6 and –6.
$x^2 - 12x + 36 = (x - 6)(x - 6)$

g) $x^2 - 4$ can be rewritten as $x^2 + 0x - 4$.
Find 2 numbers with product –4 and sum 0. The numbers are 2 and –2.
$x^2 - 4 = (x + 2)(x - 2)$

h) The GCF for x^2 and $-32x$ is x.
So, $x^2 - 32x = x(x - 32)$

Chapter 5 Section 3 Question 9 Page 254

a) Find 2 numbers with product 3 and sum 4. The numbers are 1 and 3.
$x^2 + 4x + 3 = (x + 1)(x + 3)$

b) Find 2 numbers with product 3 and sum 3.
There are no 2 numbers that satisfy these conditions.
The trinomial $x^2 + 3x + 3$ is not factorable.

c) Find 2 numbers with product 4 and sum 3.
There are no 2 numbers that satisfy these conditions.
The trinomial $x^2 + 3x + 4$ is not factorable.

d) Find 2 numbers with product 2 and sum 3. The numbers are 1 and 2.
$x^2 + 3x + 2 = (x + 1)(x + 2)$

e) Find 2 numbers with product 3 and sum –4. The numbers are –1 and –3.
$x^2 - 4x + 3 = (x - 1)(x - 3)$

f) Find 2 numbers with product –3 and sum 2. The numbers are 3 and –1.
$x^2 + 2x - 3 = (x + 3)\ (x - 1)$

Chapter 5 Section 3 Question 10 Page 254

Answers may vary.

In b), there are no 2 numbers that have a product of 3 and a sum of 3.
Using algebra tiles, the 7 tiles cannot form a rectangle that models the trinomial $x^2 + 3x + 3$.

In c), there are no 2 numbers that have a product of 4 and a sum of 3.
Using algebra tiles, the 8 tiles cannot form a rectangle that models the trinomial $x^2 + 3x + 4$.

Chapter 5 Section 3 Question 11 Page 255

a) $x^2 – 9 = (x + 3)(x – 3)$

b) $x^2 – 4(25) = x^2 – 100 = (x + 10)(x – 10)$

Chapter 5 Section 3 Question 12 Page 255

a) πx^2 (The area of a circle is πr^2, where r is the radius of the circle.)

b) $(5)^2 = 25\pi$

c) $\pi x^2 – 25\pi$

d) The GCF for πx^2 and 25π is π.
$\pi x^2 – 25\pi = \pi(x^2 – 25)$
Rewrite $x^2 – 25$ as a trinomial $\pi(x^2 + 0x – 25)$.
Find 2 numbers with a sum of 0 and a product of –25. The numbers are 5 and –5.

$\pi(x^2 – 25) = \pi(x + 5)(x – 5)$

Chapter 5 Section 3 Question 13 Page 255

a) $x^2 – 4$

b) When $x = 10$, $(10^2 – 4) = 96$
Cost is: $\$50/\text{m}^2 \times 96\ \text{m}^2 = \$4800$

Chapter 5 Section 3 Question 14 Page 255

a) Find 2 numbers that have a sum of 7 and a product of 10. The numbers are 2 and 5.

The expression for area is $(x + 2)(x + 5)$.

b) Since the length and width of the rectangle can be represented by $x + 2$ and $x + 5$, their difference is 3. Since the area is 40, the product of the length and width is 40.
The 2 numbers that have a difference of 3 and a product of 40 are 5 and 8.

The length is 8 m and the width is 5 m.

Chapter 5 Section 3 **Question 15 Page 255**

a) $x^4 - 26x^2 + 25$
$= s^2 - 26s + 25$
$= (s - 1)(s - 25)$
$= (x^2 - 1)(x^2 - 25)$
$= (x + 1)(x - 1)(x + 5)(x - 5)$

b) $x^4 - 53x^2 + 196$
$= s^2 - 53s + 196$
$= (s - 4)(s - 49)$
$= (x^2 - 4)(x^2 - 49)$
$= (x + 2)(x - 2)(x + 7)(x - 7)$

c) $x^4 - 45x^2 + 324$
$= s^2 - 45s + 324$
$= (s - 36)(s - 9)$
$= (x^2 - 36)(x^2 - 9)$
$= (x + 6)(x - 6)(x + 3)(x - 3)$

Chapter 5 Section 4 Factor Trinomials of the Form $ax^2 + bx + c$

Chapter 5 Section 4 Question 1 Page 259

a) $2x^2 + 16x + 30$
$= 2(x^2 + 8x + 15)$ Divide each term by 2, the GCF, to find the other factor.
$= 2(x + 3)(x + 5)$ Find 2 numbers whose product is 15 and whose sum is 8.

b) $4x^2 + 20x – 24$
$= 4(x^2 + 5x – 6)$ Divide each term by 4, the GCF, to find the other factor.
$= 4(x + 6)(x – 1)$ Find 2 numbers whose product is –6 and whose sum is 5.

c) $3x^2 + 18x + 15$
$= 3(x^2 + 6x + 5)$ Divide each term by 3, the GCF, to find the other factor.
$= 3(x + 1)(x + 5)$ Find 2 numbers whose product is 5 and whose sum is 6.

d) $2x^2 + 2x – 24$
$= 2(x^2 + 1x – 12)$ Divide each term by 2, the GCF, to find the other factor.
$= 2(x + 4)(x – 3)$ Find 2 numbers whose product is –12 and whose sum is 1.

e) $5x^2 + 5x – 10$
$= 5(x^2 + 1x – 2)$ Divide each term by 5, the GCF, to find the other factor.
$= 5(x + 2)(x – 1)$ Find 2 numbers whose product is –2 and whose sum is 1.

f) $3x^2 – 12x + 12$
$= 3(x^2 – 4x + 4)$ Divide each term by 3, the GCF, to find the other factor.
$= 3(x – 2)(x – 2)$ Find two numbers whose product is 4 and whose sum is –4.

Chapter 5 Section 4 Question 2 Page 259

a) $7x^2 - 77x + 210$
$= 7(x^2 - 11x + 30)$ Divide each term by 7, the GCF, to find the other factor.
$= 7(x - 5)(x - 6)$ Find two numbers whose product is 30 and whose sum is –11.

b) $6x^2 - 60x + 126$
$= 6(x^2 - 10x + 21)$ Divide each term by 6, the GCF, to find the other factor.
$= 6(x - 3)(x - 7)$ Find two numbers whose product is 21 and whose sum is –10.

c) $-3x^2 - 30x - 72$
$= -3(x^2 + 10x + 24)$ Divide each term by –3, the GCF, to find the other factor.
$= -3(x + 4)(x + 6)$ Find two numbers whose product is 24 and whose sum is 10.

d) $10x^2 - 140x - 320$
$= 10(x^2 - 14x - 32)$ Divide each term by 10, the GCF, to find the other factor.
$= 10(x - 16)(x + 2)$ Find two numbers whose product is –32 and whose sum is –14.

e) $-5x^2 + 50x - 105$
$= -5(x^2 + 10x - 21)$ Divide each term by –5, the GCF, to find the other factor.
$= -5(x - 3)(x - 7)$ Find two numbers whose product is –21 and whose sum is 10.

f) $-2x^2 + 4x + 96$
$= -2(x^2 - 2x - 48)$ Divide each term by –2, the GCF, to find the other factor.
$= -2(x - 8)(x + 6)$ Find two numbers whose product is –48 and whose sum is –2.

Chapter 5 Section 4 Question 3 Page 259

a) $1.2x^2 - 8.4x - 36$
$= 1.2(x^2 - 7x - 30)$ Factor out 1.2 to simplify the trinomial.
$= 1.2(x - 10)(x + 3)$ Find 2 numbers whose product is –30 and whose sum is –7.

b) $-2.5x^2 - 30x - 80$
$= -2.5(x^2 + 12x + 32)$ Factor out –2.5 to simplify the trinomial.
$= -2.5(x + 4)(x + 8)$ Find 2 numbers whose product is 32 and whose sum is 12.

c) $3.4x^2 - 37.4x + 95.2$
$= 3.4(x^2 - 11x + 28)$ Factor out 3.4 to simplify the trinomial.
$= 3.4(x - 7)(x - 4)$ Find 2 numbers whose product is 28 and whose sum is –11.

d) $-4.6x^2 - 55.2x - 165.6$
$= -4.6(x^2 + 12x + 36)$ Factor out –4.6 to simplify the trinomial.
$= -4.6(x + 6)(x + 6)$ Find 2 numbers whose product is 36 and whose sum is 12.

Chapter 5 Section 4 Question 4 Page 259

a) $5x^2 + 20x$
$= 5x(x + 4)$ Factor out the GCF, $5x$.

b) $3x^2 – 21x$
$= 3x(x – 7)$ Factor out the GCF, $3x$.

c) $–7x^2 + 49x$
$= –7x(x – 7)$ Factor $–7x$ out of each term.

d) $–15x^2 – 75x$
$= –15x(x + 5)$ Factor $–15x$ out of each term.

e) $8.2x^2 + 65.6x$
$= 8.2x(x + 8)$ Factor $8.2x$ out of each term.

f) $–4.9x^2 + 44.1x$
$= –4.9x(x – 9)$ Factor $–4.9x$ out of each term.

Chapter 5 Section 4 Question 5 Page 259

a) $3x^2 – 27$
$= 3(x^2 – 9)$ Factor out the GCF, 3.
$= 3(x + 3)(x – 3)$ The second factor is a difference of squares.

b) $6x^2 – 96$
$= 6(x^2 – 16)$ Factor out the GCF, 6.
$= 6(x + 4)(x – 4)$ The second factor is a difference of squares.

c) $–3x^2 + 48$
$= –3(x^2 – 16)$ Factor –3 out of each term.
$= –3(x + 4)(x – 4)$ The second factor is a difference of squares.

d) $–8x^2 + 648$
$= –8(x^2 – 81)$ Factor –8 out of each term.
$= –8(x + 9)(x – 9)$ The second factor is a difference of squares.

e) $1.2x^2 – 30$
$= 1.2(x^2 – 25)$ Factor 1.2 out of each term.
$= 1.2(x + 5)(x – 5)$ The second factor is a difference of squares.

f) $–4.5x^2 + 162$
$= –4.5(x^2 – 36)$ Factor –4.5 out of each term.
$= –4.5(x + 6)(x – 6)$ The second factor is a difference of squares.

Chapter 5 Section 4 **Question 6 Page 260**

a) $6x^2 + 48x + 96$
$= 6(x^2 + 8x + 16)$ Divide each term by 6, the GCF, to find the other factor.
$= 6(x + 4)(x + 4)$ Find 2 numbers whose product is 16 and whose sum is 8.

b) $5x^2 – 45$
$= 5(x^2 – 9)$ Factor out the GCF, 5.
$= 5(x + 3)(x – 3)$ The second factor is a difference of squares.

c) $9x^2 – 27x$
$= 9x(x – 3)$ Factor out the GCF, $9x$.

d) $10x^2 – 50x – 240$
$= 10(x^2 – 5x – 24)$ Divide each term by 10, the GCF, to find the other factor.
$= 10(x – 8)(x + 3)$ Find 2 numbers whose product is –24 and whose sum is –5.

e) $–4x^2 + 196$
$= –4(x^2 – 49)$ Factor out the GCF, –4.
$= –4(x + 7)(x – 7)$ The second factor is a difference of squares.

f) $–2x^2 + 18x$
$= –2(x – 9)$ Factor out the GCF, –2.

g) $1.5x^2 + 4.5x – 27$
$= 1.5(x^2 + 3x – 18)$ Divide each term by 1.5 to find the other factor.
$= 1.5(x + 6)(x – 3)$ Find 2 numbers whose product is –18 and whose sum is 3.

h) $–6.2x^2 + 396.8$
$= –6.2(x^2 – 64)$ Divide each term by –6.2 to find the other factor.
$= –6.2(x + 8)(x – 8)$ The second factor is a difference of squares.

Chapter 5 Section 4 Question 7 Page 260

Equivalent expressions can be found by comparing the factored forms of the two expressions. An easier approach is to expand the expression in factored form and compare the trinomials.

a) $3(x + 5)(x + 5)$
$= 3(x^2 + 5x + 5x + 25)$
$= 3(x^2 + 10x + 25)$
$= 3x^2 + 30x + 75$
$3(x + 5)(x + 5) = 3x^2 + 30x + 75$
The two expressions are equivalent.

b) $5(x + 2)(x + 1)$
$= 5(x^2 + 1x + 2x + 2)$
$= 5(x^2 + 3x + 2)$
$= 5x^2 + 15x + 10$
$5(x + 2)(x + 1) \neq 5x^2 + 3x + 2$
The two expressions are not equivalent.

c) $4(x – 6)(x – 4)$
$= 4(x^2 – 4x – 6x + 24)$
$= 4(x^2 – 10x + 24)$
$= 4x^2 – 40x + 96$
$4(x – 6)(x – 4) \neq 4x^2 – 10x + 24$
The two expressions are not equivalent.

d) $–2(x + 4)(x + 5)$
$= –2(x^2 + 5x + 4x + 20)$
$= –2(x^2 + 9x + 20)$
$= –2x^2 – 18x – 40$
$–2(x + 4)(x + 5) \neq –2x^2 – 22x – 40$
The two expressions are not equivalent.

Chapter 5 Section 4 Question 8 Page 260

a) S.A. $= 2\pi rh + \pi r^2$
S.A. $= \pi r(2h + r)$ Factor out the GCF, πr.

b) Calculate the surface area for each container and find the sum.
$\pi(10)\ [2(20) +(10)] = 500\ \pi$
$\pi(9)\ [2(18) +(9)] = 405\pi$
$\pi(8)\ [2(16) +(8)] = 192\pi$
$\pi(7)\ [2(14) +(7)] = 147\pi$
$\pi(6)\ [2(12) +(6)] = 108\pi$
Total area $= 500\pi + 405\pi + 192\pi + 147\pi + 108\pi = 1650\pi \doteq 5184$
The total surface area of the five containers is about 5184 cm^2.

c) Substitute $h = 2r$ into the expression $\pi r(2h + r)$ from part a).
The surface area formula can be simplified:
$\pi r(2h + r) = \pi r(2(2r) + r) = \pi r(4r + r) = \pi r(5r) = 5\pi r^2$

Chapter 5 Section 4 Question 9 Page 261

a) S.A. = $\pi r^2 + \pi rs$
S.A. = $\pi r(r + s)$ Factor out the GCF, πr.

b) When $r = 20$, the expression for S.A. becomes $20\pi(20 + s)$.
Substitute the value of s for each cone into the expression for S.A.
The surface area for each cone is listed in the table.

Slant Height (cm)	Surface Area (cm^2)
40	$1200\pi \doteq 3770$
45	$1300\pi \doteq 4084$
50	$1400\pi \doteq 4398$
55	$1400\pi \doteq 4712$
60	$1500\pi \doteq 5027$

c) S.A. = $\pi r(r + s)$
S.A. = $\pi r(r + 3r)$
S.A. = $\pi r(4r)$
S.A. = $4\pi r^2$

Chapter 5 Section 4 Question 10 Page 261

a)

$$h = -4.9t^2 + 76t$$
$$h = -4.9t\left(t - \frac{76t}{4.9}\right)$$

b)

Time (s)	Height Increment (m)	Height (m)
0	0	0
1	71.1	71.1
2	61.3	132.4
3	51.5	183.9
4	41.7	225.6
5	31.9	257.5
6	22.1	279.6
7	12.3	291.9
8	2.5	294.4
9	–7.3	287.1
10	–17.1	270.0

From the table, the maximum height is about 295 m.

c) 65% of 295 is about 192 m.
Yes, the manufacturer's claim that the fountain reaches heights over 183 m is reasonable since 192 > 183.

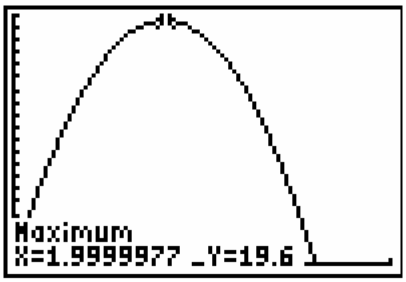
Chapter 5 Section 4 Question 11 Page 262

a) For the main fountain, the relation is $h = -4.9t^2 + 19.6t$.
For the smaller fountain, the relation is $h = -4.9t^2 + 14.7t$

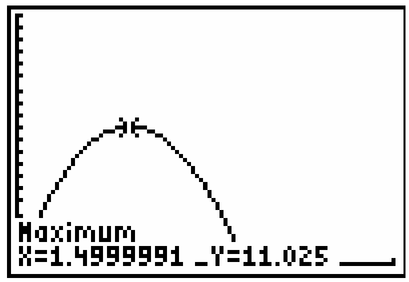
b) For the main fountain the factored form is: $h = -4.9t(t - 4)$
For the smaller fountain the factored form is: $h = -4.9t(t - 3)$

c) Graph each relation to find the maximum height.

Main fountain:



Small fountain:



The maximum height is 19.6 m.

The maximum height is 11.025 m.

Chapter 5 Section 4 Question 12 Page 262

Solutions for Achievement Checks are in the *Teacher Resource*.

Chapter 5 Section 4 Question 13 Page 263

a) $(3x - 5)(3x + 5)$
$= 9x^2 + 15x - 15x - 25$
$= 9x^2 - 25$

b) $(4x + 7)(4x - 7)$
$= 16x^2 - 28x + 28x - 49$
$= 16x^2 - 49$

c) $(5x + 2)(5x - 2)$
$= 25x^2 - 10x + 10x - 4$
$= 25x^2 - 4$

Pattern is: $(ax + b)(ax - b) = a^2x^2 - b^2$

Chapter 5 Section 4 Question 14 Page 263

a) $64x^2 - 9 = 8^2x^2 - 3^2 = (8x + 3)(8x - 3)$

b) $49x^2 - 36 = 7^2x^2 - 6^2 = (7x + 6)(7x - 6)$

c) $100x^2 - 9 = 10^2x^2 - 3^2 = (10x + 3)(10x - 3)$

Chapter 5 Section 4 Question 15 Page 263

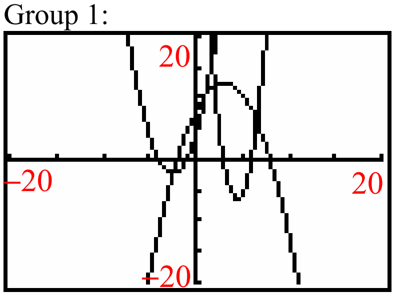
a) $2x^2 + 19x + 24$ (Decompose the middle term $19x$.)
$= 2x^2 + 16x + 3x + 24$ (Find two numbers with product $2 \times 24 = 48$ and sum 19; 16 and 3)
$= 2x(x + 8) + 3(x + 8)$ (Factor the first and second pairs of terms.)
$= (x + 8)(2x + 3)$ (Factor out the common binomial factor.)

b) $10x^2 + 27x + 5$ (Decompose the middle term $27x$.)
$= 10x^2 + 25x + 2x + 5$ (Find two numbers with product $5 \times 10 = 50$ and sum 27; 25 and 23)
$= 5x(2x + 5) + 1(2x + 5)$ (Factor the first and second pairs of terms.)
$= (2x + 5)(5x + 1)$ (Factor out the common binomial factor.)

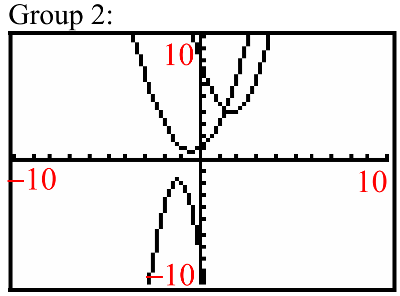
c) $12x^2 + 13x + 3$ (Decompose the middle term $13x$.)
$= 12x^2 + 4x + 9x + 3$ (Find two numbers with product $12 \times 3 = 36$ and sum 13; 4 and 9)
$= 4x(3x + 1) + 3(3x + 1)$ (Factor the first and second pairs of terms.)
$= (3x + 1)(4x + 3)$ (Factor out the common binomial factor.)

Chapter 5 Section 4 Question 16 Page 263

a) Group 1:



Group 2:



b) They all have x-intercepts.

c) None have x-intercepts.

d) Only expressions that can be factored have x-intercepts.
Group 1:
$x^2 + 5x + 4 = (x + 4)(x + 1)$
$3x^2 – 27x + 54 = 3(x^2 – 9x + 18) = 3(x – 6)(x – 3)$
$–0.5x^2 + 3x + 8 = –0.5(x^2 + 6x + 16) = –0.5(x + 2)(x + 8)$

Group 2:
For $x^2 + x + 1$, there are no 2 numbers that have a product of 1 and a sum of 1.
The trinomial is not factorable.
For $–4x^2 – 10x – 8$, or $–4(x^2 + 2.5x + 2)$, there are no 2 numbers that have a product of 2.5 and a sum of 2. The trinomial is not factorable.
For $1.5x^2 – 5x + 8$, or $1.5(x^2 + \frac{10}{3}x + \frac{16}{3})$, there are no 2 numbers that have a product of 10 and a sum of 16. The trinomial is not factorable.

Only expressions that can be factored have x-intercepts.

Chapter 5 Section 5 The x-Intercepts of a Quadratic Relation

Chapter 5 Section 5 Question 1 Page 271

The x-intercepts are the x-coordinates of the points where the graph crosses the x-axis.

a) 8 and –1

b) –3

Chapter 5 Section 5 Question 2 Page 272

a) $x = -4$ and $x = 6$ (The graph intersects the x-axis at (–4, 0) and (6, 0).)

b) There are no zeros since the graph does not cross the x-axis.

Chapter 5 Section 5 Question 3 Page 272

Find the zeros by setting each factor to zero.

a) $x = 5$ and $x = -3$

b) $x = 4$ and $x = 1$

c) $x = 9$

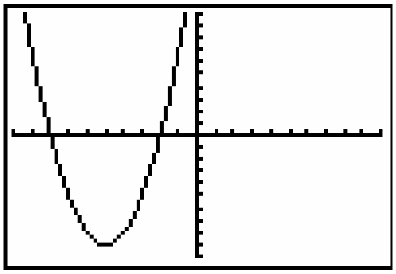
d) $x = 7$ and $x = -6$

e) $x = -8$ and $x = -2$

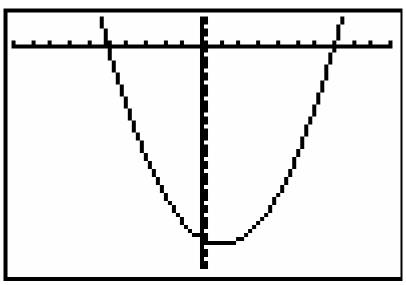
f) $x = 0$ and $x = -5$

Chapter 5 Section 5 Question 4 Page 272

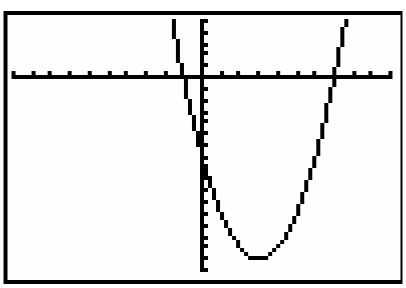
a) $y = x^2 + 10x + 16$ (Find 2 numbers that add to 10 and multiply to 16.)
$y = (x + 2)(x + 8)$
The zeros are at $x = -2$ and $x = -8$.



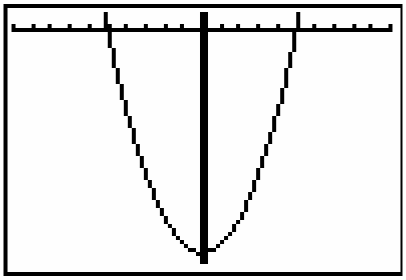
b) $y = x^2 - 2x - 35$ (Find 2 numbers that add to –2 and multiply to –35.)
$y = (x - 7)(x + 5)$
The zeros are at $x = 7$ and $x = -5$.



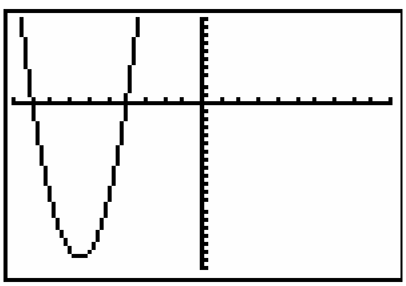
c) $y = x^2 - 6x - 7$ (Find 2 numbers that add to –6 and multiply to –7.)
$y = (x - 7)(x + 1)$
The zeros are at $x = 7$ and $x = -1$.



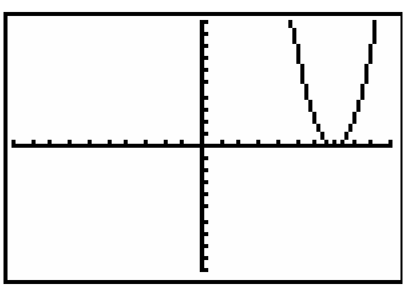
d) $y = 5x^2 – 125$ (Factor out the GCF, 5.)
$y = 5(x^2 – 25)$ (The second factor is a difference of squares)
$y = (x – 5)(x + 5)$
The zeros are at $x = 5$ and $x = –5$.



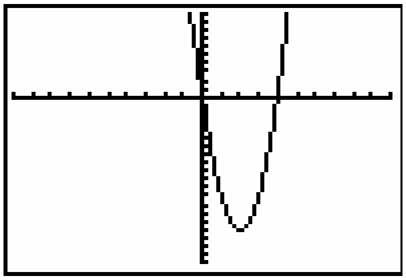
e) $y = 3x^2 + 39x + 108$ (Factor out the GCF, 3.)
$y = 3(3x^2 + 13x + 36)$ (Find 2 numbers that add to 13 and multiply to 36.)
$y = 3(x + 4)(x + 9)$
The zeros are at $x = –4$ and $x = –9$.



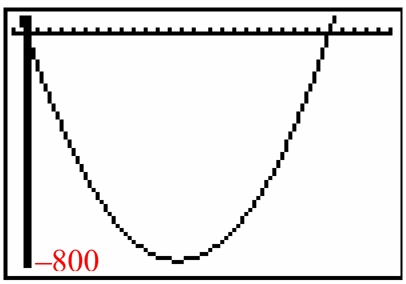
f) $y = 2x^2 – 28x + 98$ (Factor out the GCF, 3.)
$y = 2(x^2 – 14x + 49)$ (Find 2 numbers that add to –14 and multiply to 49.)
$y = 2(x – 7)(x – 7)$ (Both factors are the same. There is only one zero.)
The zero is at $x = 7$.



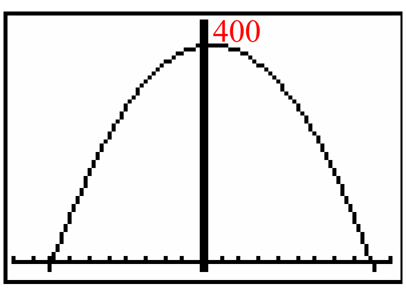
a) $y = 4x^2 - 16x$ (Factor out the GCF, $4x$.)
$y = 4x(x - 4)$
$y = 4(x - 0)(x - 4)$ (Write the first factor as $(x - 0)$.)
The zeros are at $x = 0$ and $x = 4$.



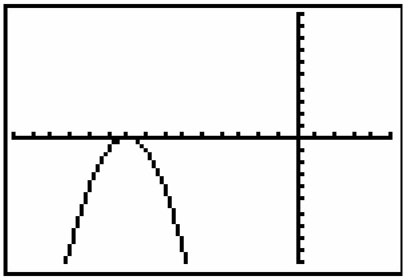
b) $y = 5x^2 - 125x$ (Factor out the GCF, $5x$.)
$y = 5x(x - 25)$
$y = 5(x - 0)(x - 25)$ (Write the first factor as $(x - 0)$.)
The zeros are at $x = 25$ and $x = 0$.



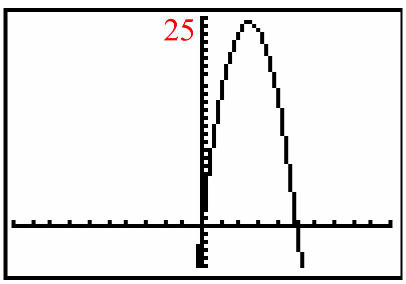
c) $y = -5x^2 + 5x + 360$ (Factor out the GCF, –5.)
$y = -5(x^2 - 1x - 72)$ (Find 2 numbers that add to –1 and multiply to –72.)
$y = -5(x - 9)(x + 8)$
The zeros are at $x = 9$ and $x = -8$.



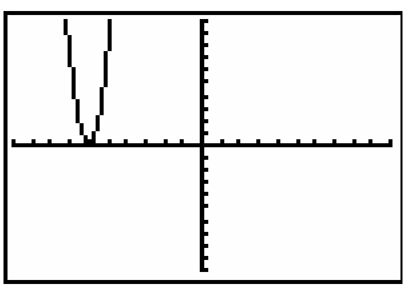
d) $y = -x^2 - 18x - 81$ (Factor out the GCF, –1.)
$y = -1(x^2 + 18x + 81)$ (Find 2 numbers that add to 18 and multiply to 81.)
$y = -1(x + 9)(x + 9)$ (Both factors are the same. There is only one zero.)
The zero is at $x = -9$.



e) $y = -3.9x^2 + 19.5x$ (Factor out the GCF, $-3.9x$.)
$y = -3.9x(x - 5)$
$y = -3.9(x - 0)(x - 5)$ (Write the first factor as $(x - 0)$.)
The zeros are at $x = 0$ and $x = 5$.



f) $y = 7.5x^2 + 90x + 270$ (Factor out the GCF, 7.5.)
$y = 7.5(x^2 + 12x + 36)$ (Find 2 numbers that add to 12 and multiply to 36.)
$y = 7.5(x + 6)(x + 6)$ (Both factors are the same. There is only one zero.)
The zero is at $x = -6$.



Chapter 5 Section 5 Question 6 Page 272

a) The graph is a parabola that opens upward and has vertex at (15, 2).
It has no zeros as it does not cross the *x*-axis.

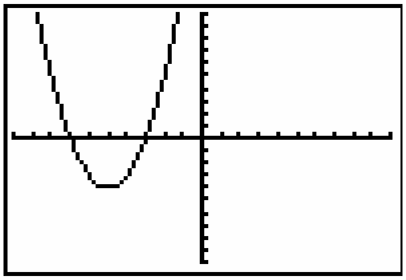
b) The graph is a parabola that opens downward and has vertex at (–2, 9).
It crosses the *x*-axis twice and has 2 zeros.

c) The graph is a parabola that opens downward and has vertex at (8, –6).
It has no zeros as it does not cross the *x*-axis.

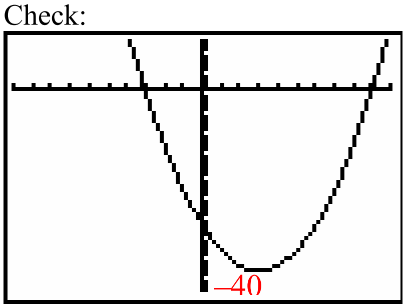
d) The graph is a parabola that opens upward and has vertex at (–3. –10).
It crosses the *x*-axis twice and has 2 zeros.

Chapter 5 Section 5 Question 7 Page 272

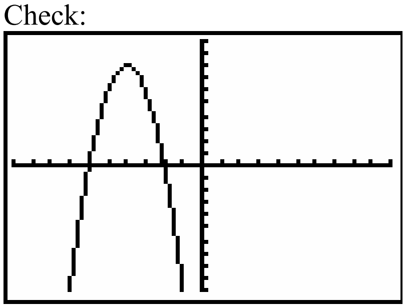
a) $y = (x + 5)^2 - 4$ (Expand and simplify.)
$y = (x + 5)(x + 5) - 4$
$y = x^2 + 5x + 5x + 25 - 4$
$y = x^2 + 10x + 21$ (standard form)
$y = (x + 3)(x + 7)$ (intercept form)
Check:



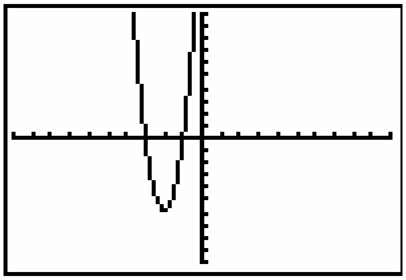
b) $y = (x - 3)^2 - 36$ (Expand and simplify.)
$y = (x - 3)(x - 3) - 36$
$y = x^2 - 3x - 3x + 9 - 36$
$y = x^2 - 6x - 27$ (standard form)
$y = (x - 9)(x + 3)$ (intercept form)
Check:



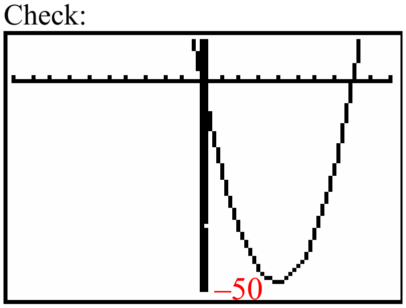
c) $y = -2(x + 4)^2 + 8$ (Expand and simplify.)
$y = -2(x + 4)(x + 4) + 8$
$y = -2(x^2 + 4x + 4x + 16) + 8$
$y = -2(x^2 + 8x + 16) + 8$
$y = -2x^2 - 16x - 32 + 8$
$y = -2x^2 - 16x - 24$ (standard form)
$y = -2(x^2 + 8x + 12)$
$y = -2(x + 2)(x + 6)$ (intercept form)
Check:



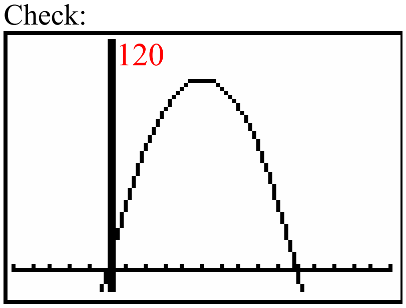
d) $y = 6(x + 2)^2 - 6$ (Expand and simplify.)
$y = 6(x + 2)(x + 2) - 6$
$y = 6(x^2 + 2x + 2x + 4) - 6$
$y = 6(x^2 + 4x + 4) - 6$
$y = 6x^2 + 24x + 24 - 6$
$y = 6x^2 + 24x + 18$ (standard form)
$y = 6(x^2 + 4x + 3)$
$y = 6(x + 1)(x + 3)$ (intercept form)
Check:



e) $y = 3(x - 4)^2 - 48$ (Expand and simplify.)
$y = 3(x - 4)(x - 4) - 48$
$y = 3(x^2 - 4x - 4x + 16) - 48$
$y = 3(x^2 - 8x + 16) - 48$
$y = 3x^2 - 24x + 48 - 48$
$y = 3x^2 - 24x$ (standard form)
$y = 3x(x - 8)$ (intercept form, one zero is at $x = 0$)
Check:



f) $y = -4(x - 5)^2 + 100$ (Expand and simplify.)
$y = -4(x - 5)(x - 5) + 100$
$y = -4(x^2 - 5x - 5x + 25) + 100$
$y = -4(x^2 - 10x + 25) + 100$
$y = -4x^2 + 40x - 100 + 100$
$y = -4x^2 + 40x$ (standard form)
$y = -4x(x - 10)$ (intercept form, one zero is at $x = 0$)
Check:



Chapter 5 Section 5 **Question 8 Page 273**

a) $h = -1.25d^2 + 1.875d$ (Factor –1.25 out of each term.)
$h = -1.25d(d - 1.5)$

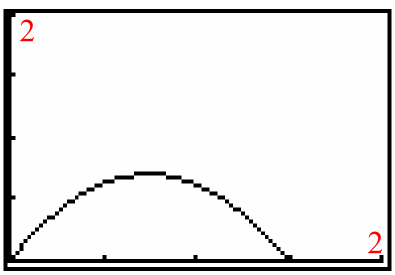
b) The zeros are $d = 0$ and $d = 1.5$.
The skateboarder will make it across the gap that is 1.3 m wide because she will land at a horizontal distance of 1.5 m from her starting point.

c)

Horizontal Distance (m)	Height (m)
0	0
0.25	0.39
0.50	0.63
0.75	0.70
1.00	0.63
1.25	0.39
1.50	0

d) From the table, the maximum height is about 0.70 m.

e)



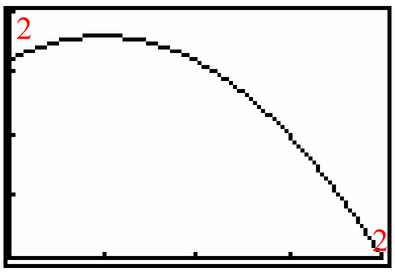
Chapter 5 Section 5 Question 9 Page 273

a) To find the height of the ledge, calculate the *y*-intercept of the relation.
$h = -0.8(0)^2 + 0.8(0) + 1.6 = 1.6$
The height of the ledge is 1.6 m.

b) $h = -0.8d^2 + 0.8d + 1.6$ (Factor –0.8 out of each term.)
$h = -0.8(d^2 - d - 2)$ (Find 2 numbers that have a product of –2 and a sum of –1.)
$h = -0.8(d - 2)(d + 1)$
The zeros of the relation are $d = 2$ and $d = -1$.

c) The skateboarder will land when he is at a distance of 2 m from the ledge (at the second zero of the relation).

d)

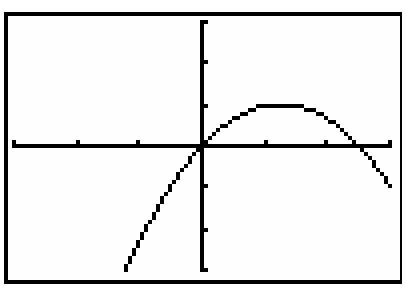


Chapter 5 Section 5 Question 10 Page 274

a) $h = -0.65d^2 + 1.625d$ (Factor –0.65 out of each term.)
$h = -0.65d(d - 2.5)$
The zeros are $d = 0$ and $d = 2.5$.

b) This situation is modelled by the second zero of the relation.
The bucket is 2.5 m from the beanbag.

c) The maximum height can be found by graphing the relation.



The beanbag's maximum height is about 1.0 m.

Chapter 5 Section 5 **Question 11 Page 274**

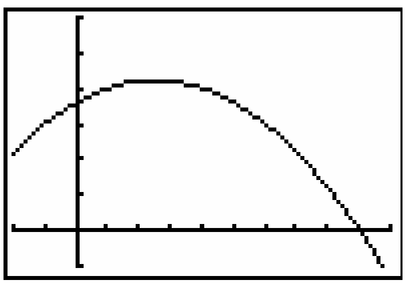
a) $h = –0.1d^2 + 0.5d + 3.6$ (Factor –0.1 out of each term.)
$h = –0.1(d^2 – 5d – 36)$ (Factor the trinomial.)
$h = –0.8(d – 9)(d + 4)$

The zeros of the relation are $d = 9$ and $d = –4$.

b) This situation is modelled by the second zero of the relation.

The car will land at 9 m from the ramp.

c) ***Method 1***
The maximum height can be found by graphing the relation.



The car will not hit the ceiling that is 10 m high because the maximum height of the graph is about 4.2.

Method 2
Since parabolas are symmetrical, the maximum point will occur halfway between the two intercepts, 9 and –4. The maximum should be the point (2.5, y).
$h = –0.1d^2 + 0.5d + 3.6$
$h = –0.1(2.5)^2 + 0.5(2.5) + 3.6$
$h == 4.225$

The car will not hit the ceiling that is 10 m high because the maximum height of the graph is about 4.2.

Chapter 5 Section 5 Question 12 Page 275

a) For $y = 3x^2 + 21x + 30$, $a = 3$, $b = 21$, and $c = 30$.

$$x = \frac{-21 \pm \sqrt{(21)^2 - 4(3)(30)}}{2(3)}$$
$$= \frac{-21 \pm \sqrt{441 - 360}}{6}$$
$$= \frac{-21 \pm \sqrt{81}}{6}$$
$$= \frac{-21 \pm 9}{6}$$
$$x = \frac{-30}{6} \text{ or } \frac{-12}{6}$$
$$x = -5 \text{ or } -2$$

The zeros of the relation are $x = -5$ and $x = -2$.

b) For $y = 16x^2 - 40x - 75$, $a = 16$, $b = -40$, and $c = -75$.

$$x = \frac{-(-40) \pm \sqrt{(-40)^2 - 4(16)(-75)}}{2(16)}$$
$$= \frac{40 \pm \sqrt{1600 + 4800}}{32}$$
$$= \frac{40 \pm \sqrt{6400}}{32}$$
$$= \frac{40 \pm 80}{32}$$
$$x = \frac{120}{32} \text{ or } \frac{-40}{32}$$
$$x = \frac{15}{4} \text{ or } -\frac{5}{4}$$

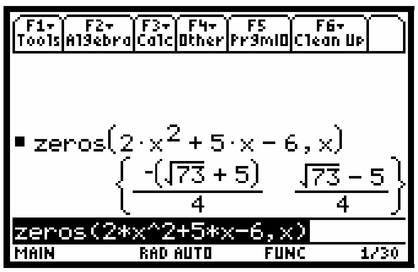
The zeros of the relation are $x = \frac{15}{4}$ and $x = -\frac{5}{4}$.

c) For $y = 2x^2 + 5x - 6$, $a = 2$, $b = 5$, and $c = -6$

$$x = \frac{-5 \pm \sqrt{(5)^2 - 4(2)(-6)}}{2(2)}$$
$$= \frac{-5 \pm \sqrt{25 + 48}}{4}$$
$$= \frac{-5 \pm \sqrt{73}}{4}$$
$$x = \frac{-5 + \sqrt{73}}{4} \text{ or } \frac{-5 - \sqrt{73}}{4}$$

The zeros of the relation are $x = \frac{-5 + \sqrt{73}}{4}$ and $x = \frac{-5 - \sqrt{73}}{4}$.

You could also use CAS. Note the slightly different formats of the answers.



Chapter 5 Section 5 Question 13 Page 275

a) $a = 5$, $b = 3$, and $c = 15$
$b^2 - 4ac = (3)^2 - 4(5)(15) = -291$
Since, $-291 < 0$, there are no zeros.

b) $a = 25$, $b = 60$, and $c = 36$
$b^2 - 4ac = (60)^2 - 4(25)(36) = 0$
Since, $0 \geq 0$ is true, there are zeros.

c) $a = 7$, $b = -10$, and $c = 5$
$b^2 - 4ac = (-10)^2 - 4(7)(5) = -40$
Since, $-40 < 0$, there are no zeros.

Chapter 5 Section 5 **Question 14 Page 275**

Find the largest possible zero (second zero) of this relation as the value of θ varies.

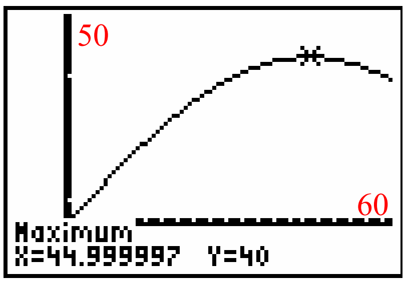
$$h = -\frac{0.0125}{(\cos\theta)^2}d^2 + (\tan\theta)d$$

$$h = -\frac{0.0125}{(\cos\theta)^2}d\left(d - \frac{\tan\theta(\cos\theta)^2}{0.0125}\right)$$

The zeros are at $h = 0$ and $h = \frac{\tan\theta(\cos\theta)^2}{0.0125}$.

Consider the new relation $y = \frac{\tan x(\cos x)^2}{0.0125}$.

Find its maximum value by graphing.



The maximum occurs at (45, 40).

The angle of elevation that allows the cannonball to travel the farthest is 45º and the greatest distance is 40 m.

Chapter 5 Section 6 Solve Problems Involving Quadratic Relations

Chapter 5 Section 6 Question 1 Page 281

a) $x = 5$ and $x = –4$

b) $x = –9$ and $x = –15$

c) $x = –3$ and $x = –19$

d) $x = 8$ and $x = –10$

Chapter 5 Section 6 Question 2 Page 281

Factor the trinomials using methods learned in previous sections.

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

b) $y = x^2 + 11x + 28$
$y = (x + 4)(x + 7)$

c) $y = 3x^2 + 39x + 120$ (Factor out the GCF, 3.)
$y = 3(x^2 + 13x + 40$
$y = 3(x + 5)(x + 8)$

d) $y = –2x^2 + 10x + 132$ (Factor out the GCF, –2.)
$y = –2(x^2 – 5x – 66)$
$y = –2(x – 11)(x + 6)$

Chapter 5 Section 6 Question 3 Page 281

Factor the expressions using methods learned in previous sections.

a) $y = x^2 + 3x - 28$
$y = (x - 4)(x + 7)$
$x = -4$ and $x = 7$ are the zeros.

b) $y = x^2 - 16$
$y = (x - 4)(x + 4)$
$x = 4$ and $x = -4$ are the zeros.

c) $y = 2x^2 - 2x - 112$
$y = 2(x^2 - 1x - 56)$
$y = 2(x + 7)(x - 8)$
$x = -7$ and $x = 8$ are the zeros.

d) $y = 3x^2 + 21x + 294$
$y = 3(x^2 + 7x + 98)$
$y = 3(x - 7)(x + 14)$
$x = 7$ and $x = -14$ are the zeros.

e) $y = 5x^2 - 280$
$y = 5(x^2 - 56)$ (This does not factor; use the pattern for the difference of two squares.)
$y = \left(x - \sqrt{56}\right)\left(x + \sqrt{56}\right)$
$y = \sqrt{56}$ and $-\sqrt{56}$ are the zeros.

f) $y = -2x^2 + 18$
$y = -2(x^2 - 9)$
$y = -2(x - 3)(x + 3)$
$x = 3$ and $x = -3$ are the zeros.

g) $y = -4.9x^2 + 24.5x + 245$ (Factor –4.9 out of each term.)
$y = -4.9(x^2 - 5x - 50)$
$y = -4.9(x - 10)(x + 5)$
$x = 10$ and $x = -5$ are the zeros.

h) $y = 2.5x^2 + 50x - 560$ (Factor 2.5 out of each term.)
$y = 2.5(x^2 + 20x - 224)$
$y = 2.5(x - 8)(x + 28)$
$x = 8$ and $x = -28$ are the zeros.

Chapter 5 Section 6 Question 4 Page 281

a) The zeros are 2 and 10. Halfway between is 6.
The equation of the axis of symmetry is $x = 6$.

b) The zeros are –7 and 1. Halfway between is –3.
The equation of the axis of symmetry is $x = -3$.

c) The zeros are –2 and 2. Halfway between is 0.
The equation of the axis of symmetry is $x = 0$.

d) There are no zeros but we can choose two symmetric points such as(–9, –7) and (–1, –7).
Halfway between is (–5, –7).
The equation of the axis of symmetry is $x = -5$.

Chapter 5 Section 6 Question 5 Page 282

a) $y = (x + 4)(x + 12)$
The zeros are –4 and –12. Halfway between is –8.
The equation of the axis of symmetry is $x = -8$.

b) $y = (x - 7)(x - 1)$
The zeros are 7 and 1. Halfway between is 4.
The equation of the axis of symmetry is $x = 4$.

c) $y = 8(x - 5)(x + 9)$
The zeros are 5 and –9. Halfway between is –2.
The equation of the axis of symmetry is $x = -2$.

d) $y = -5(x + 12)(x - 4)$
The zeros are –12 and 4. Halfway between is –4.
The equation of the axis of symmetry is $x = -4$.

e) $y = 6x(x + 10)$
The zeros are 0 and –10. Halfway between is –5.
The equation of the axis of symmetry is $x = -5$.

f) $y = -3x(x - 8)$
The zeros are 0 and 8. Halfway between is 4.
The equation of the axis of symmetry is $x = 4$.

Chapter 5 Section 6 Question 6 Page 282

a) $y = (x + 4)(x + 12)$ (Expand and simplify.)
$y = x^2 + 12x + 4x + 48$
$y = x^2 + 16x + 48$ (standard form)
$y = (x + 12)(x + 4)$ (intercept form)
The zeros are –12 and –4. The equation of the axis of symmetry is $x = -8$.
The vertex is $(-8, (-8)^2 + 16(-8) + 48) = (-8, -16)$
The equation in vertex form is $y = (x + 8)^2 - 16$.

b) $y = (x - 7)(x - 1)$ (Expand and simplify.)
$y = x^2 - 1x - 7x + 7$
$y = x^2 - 8x + 7$ (standard form)
$y = (x - 7)(x - 1)$ (intercept form)
The zeros are 7 and 1. The equation of the axis of symmetry is $x = 4$.
The vertex is $(4, (4)^2 - 8(4) + 7) = (4, -9)$
The equation in vertex form is $y = (x - 4)^2 - 9$.

c) $y = 8(x - 5)(x + 9)$ (Expand and simplify.)
$y = 8(x^2 + 9x - 5x - 45)$
$y = 8(x^2 + 4x - 45)$
$y = 8x^2 + 32x - 360$ (standard form)
$y = 8(x^2 + 4x - 45)$
$y = 8(x - 5)(x + 9)$ (intercept form)
The zeros are 5 and –9. The equation of the axis of symmetry is $x = -2$.
The vertex is $(-2, 8(-2)^2 + 32(-2) - 360) = (-2, -392)$
The equation in vertex form is $y = 8(x + 2)^2 - 392$.

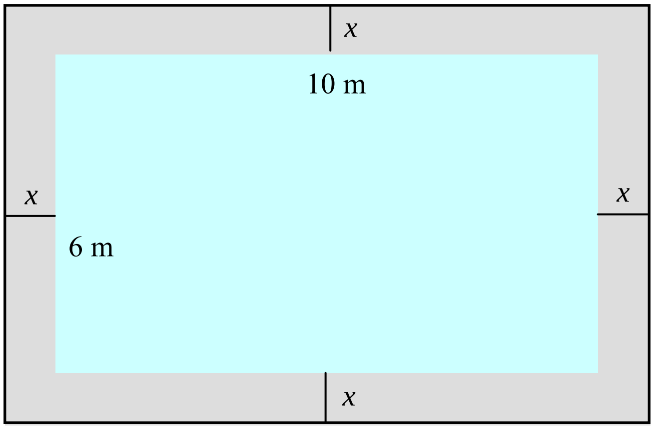
d) $y = -5(x + 12)(x - 4)$ (Expand and simplify.)
$y = -5(x^2 - 4x + 12x - 48)$
$y = -5(x^2 + 8x - 48)$
$y = -5x^2 - 40x + 240$ (standard form)
$y = -5(x^2 + 8x - 48)$
$y = -5(x - 4)(x + 12)$ (intercept form)
The zeros are 4 and –12. The equation of the axis of symmetry is $x = -4$.
The vertex is $(-4, -5(-4)^2 - 40(-4) + 240) = (-4, 320)$
The equation in vertex form is $y = -5(x + 4)^2 + 320$.

e) $y = 6x(x + 10)$ (Expand and simplify.)
$y = 6x^2 + 60x$ (standard form)
$y = 6x(x + 10)$ (intercept form)
The zeros are 0 and –10. The equation of the axis of symmetry is $x = -5$.
The vertex is $(-5, 6(-5)^2 + 60(-5)) = (-5, -150)$
The equation in vertex form is $y = 6(x + 5)^2 - 150$.

f) $y = -3x(x - 8)$ (Expand and simplify.)
$y = -3x^2 + 24x$ (standard form)
$y = -3x(x - 8)$ (intercept form)
The zeros are 0 and 8. The equation of the axis of symmetry is $x = 4$.
The vertex is $(4, -3(4)^2 + 24(4)) = (4, 48)$
The equation in vertex form is $y = -3(x - 4)^2 + 48$.

Chapter 5 Section 6 **Question 7 Page 282**

a)



b) total length: $2x + 10$; total width: $2x + 6$

c) Let the area be A cm^2.
$A = (2x + 10)(2x + 6)$
$A = 4x^2 + 12x + 20x + 60$
$A = 4x^2 + 32x + 60$

d) $4x^2 + 32x + 60 = 320$ (Subtract 320 from each side to change equation to standard form.)
$4x^2 + 32x + 60 – 320 = 320 –320$
$4x^2 + 32x – 260 = 0$
$4(x^2 + 8x – 65) = 0$
$4(x + 13)(x – 5) = 0$
The zeros are –13 and 5, but –13 is not a reasonable answer for the width of the deck.

The greatest possible width of the deck is 5 m.

Chapter 5 Section 6 **Question 8 Page 282**

a) The cardboard used to make the box equals the cardboard of dimensions 100 cm by 100 cm with 4 small squares of dimensions x by x removed.

The area of cardboard actually used is $100^2 – 4x^2$.

b) Since the surface area is the same as the area of cardboard used,
$100^2 – 4x^2 = 6400$
$10\ 000 – 4x^2 = 6400$ (Subtract 10 000 from each side.)
$– 4x^2 = –3600$ (Divide each side by –4.)
$x^2 = 900$
$x = 30$ or $x = –30$, but $x = –30$ is not a reasonable answer for length.

The height of the box is 30 cm.

Chapter 5 Section 6 Question 9 Page 283

a) Let the area be *A*.

$$A = (2x+6)(8x-16)$$
$$= 16x^2 - 32x + 48x - 96$$
$$= 16x^2 + 16x - 96$$

b) When $A = 576$,

$$16x^2 + 16x - 96 = 576$$
$$16x^2 + 16x - 96 - 576 = 575 - 576$$
$$16x^2 + 16x - 672 = 0$$
$$16(x^2 + 1x - 42) = 0$$
$$16(x+7)(x-6) = 0$$

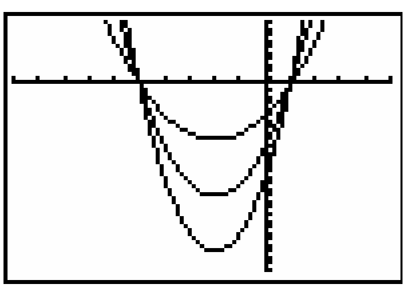
The zeros are 6 and –7, but –7 is not a reasonable answer for this situation.

The value of *x* is 6.

Chapter 5 Section 6 Question 10 Page 283

a) Answers may vary. Three examples are:
$y = x^2 + 4x - 5 = (x + 5)(x - 1)$
$y = 2x^2 + 8x - 10 = 2(x + 5)(x - 1)$
$y = 3x^2 + 12x - 15 = 3(x + 5)(x - 1)$

b) Answers may vary. For example:



c) The typical equation with this property is of the form $y = a(x + 5)(x - 1)$.
To find the value of *a*, substitute the point (–3, –20) into the equation.
$-20 = a(-3 + 5)(-3 - 1)$
$-20 = -8a$
$a = 2.5$

The required equation is:
$y = 2.5(x + 5)(x - 1)$
$y = 2.5(x^2 - x + 5x - 5)$
$y = 2.5(x^2 + 4x - 5)$
$y = 2.5x^2 + 10x - 12.5$

Chapter 5 Section 6 **Question 11 Page 283**

a) Substitute $d = 8$ into the equation $T = d^2 + d$.
$T = 8^2 + 8 = 72$

Diagram 8 needs 72 squares.

b) Substitute $T = 110$ into the equation $T = d^2 + d$.

$$\begin{aligned} 110 &= d^2 + d \\ d^2 + d - 110 &= 0 \\ (d - 10)(d + 11) &= 0 \\ d &= 10 \text{ or } d = -11 \end{aligned}$$

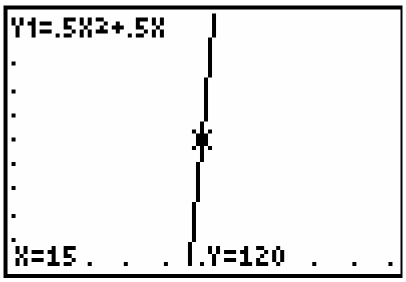
The reasonable answer is diagram 10.

Chapter 5 Section 6 Question 12 Page 283

a) Substitute $L = 7$ into the equation $T = 0.5L^2 + 0.5L$.
$T = 0.5(7)^2 + 0.5(7) = 28$

Layer 7 has 28 logs.

b) ***Method 1***
Graph the relation $y = 0.5x^2 + 0.5x$ and determine the value x when $y = 120$.
(Use the TRACE feature.)



There would be 15 layers for 120 logs.

Method 2
Use algebra.

$$\begin{aligned} 120 &= 0.5L^2 + 0.5L \\ 0.5L^2 + 0.5L - 120 &= 0 \\ 0.5(L^2 + L - 240) &= 0 \\ 0.5(L - 15)(L + 16) &= 0 \\ L &= 15 \text{ or } -16 \end{aligned}$$

There would be 15 layers for 120 logs.
(–16 is not a reasonable answer for the number of layers.)

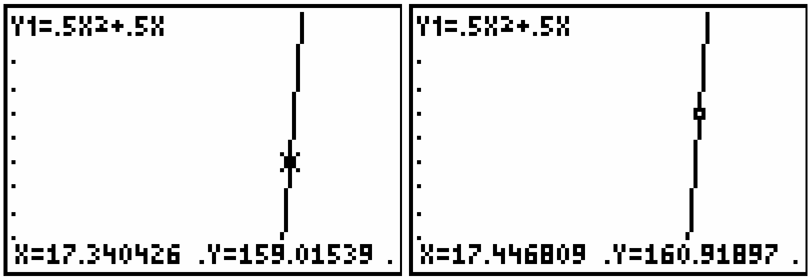
Method 3
Use the quadratic formula.
For $y = 0.5x^2 + 0.5x - 120 = 0$, $a = 0.5$, $b = 0.5$, and $c = -120$.

$$\begin{aligned} x &= \frac{-0.5 \pm \sqrt{(0.5)^2 - 4(0.5)(-120)}}{2(0.5)} \\ &= \frac{-0.5 \pm \sqrt{0.25 + 240}}{1} \\ &= -0.5 \pm \sqrt{240.25} \\ &= -0.5 \pm 15.5 \\ &= 15 \text{ or } -16 \end{aligned}$$

There would be 15 layers for 120 logs.
(–16 is not a reasonable answer for the number of layers.)

c) No, 160 logs would not fit in the pattern. Explanations may vary.

Method 1
Graph the relation $y = 0.5x^2 + 0.5x$ and determine the value x when $y = 160$.
(Use the TRACE feature.)



There is no point on the graph where Y is 160 and X is an integer.

Method 2
Use algebra.

$$160 = 0.5L^2 + 0.5L$$
$$0.5L^2 + 0.5L - 160 = 0$$
$$0.5(L^2 + L - 320) = 0$$

There are no 2 numbers that have a sum of 1 and a product of –320.
The trinomial cannot be factored.

Method 3
Use the quadratic formula.
For $y = 0.5x^2 + 0.5x - 160 = 0$, $a = 0.5$, $b = 0.5$, and $c = -160$.

$$x = \frac{-0.5 \pm \sqrt{(0.5)^2 - 4(0.5)(-160)}}{2(0.5)}$$
$$= \frac{-0.5 \pm \sqrt{0.25 + 320}}{1}$$
$$= -0.5 \pm \sqrt{320.25}$$
$$\approx 17.40 \text{ or } -17.91$$

Neither of the values of x is a positive integer.
There is no layer with 160 logs.

Chapter 5 Section 6 Question 13 Page 284

a) Find the zeros of the equation.

$h = -4.9t^2 + 44.1t$

$h = -4.9t(t - 9)$

The zeros are at $t = 0$ and $t = 9$.

The rocket will hit the ground at 9 s.

b) The maximum height occurs at the vertex.
The zeros are 0 and 9. The equation of the axis of symmetry is $t = 4.5$.
Substitute $t = 4.5$ into the equation.

$h = -4.9(4.5)^2 + 44.1(4.5)$

$h = -99.225 + 198.45$

$h = 99.225$

The maximum height reached is 99.225 m.

c) No, it takes 4.5 s to fall from its highest point until it hits the ground. This is longer than 2.5 s.

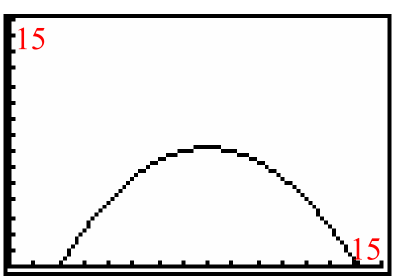
Chapter 5 Section 6 Question 14 Page 284

a) $t = -0.2x^2 + 3.2x - 5.6$
$t = -0.2(x^2 - 16x - 28)$
$t = -0.2(x - 2)(x - 14)$
The zeros are at $x = 2$ and $x = 14$.

b) The zeros are 2 and 14. The equation of the axis of symmetry is $x = 6$.
Substitute $x = 6$ into the equation.
$t = -0.2(8)^2 + 3.2(8) - 5.6$
$t = -12.8 + 25.6 - 5.6$
$t = 7.2$
The vertex is (8, 7.2).

The second coordinate of the vertex, 7.2, represents the maximum number of hours the engine can run on a given amount of fuel at power setting 8.

c)



From the graph, the zeros are at 2 and 14 and the vertex is at (8, 7.2).

Chapter 5 Section 6 Question 15 Page 284

a) $h = –0.05d^2 + 1.15d$
$h = –0.05d(d – 23d)$

b) Danny took off at 0 m and landed at 23 m. The distance between is 23 m.

c) The zeros are 2 and 23. The equation of the axis of symmetry is $d = 11.5$.
Substitute $d = 11.5$ in the equation.
$h = –0.05(11.5)^2 + 1.15(11.5)$
$h = –6.6125 + 13.225$
$h = 6.6125$

Danny's maximum height above the Great wall is about 6.61 m.

Chapter 5 Section 6 Question 16 Page 285

a) The relation is in vertex form: $h = -1.5(d - 1)^2 + 1.5$, with vertex at (1, 1.5).
One zero is at 0 and the axis of symmetry is at $d = 1$.
By symmetry, the other zero must be at $d = 2$.

The horizontal distance is 2 m.

b) Since the shape of the water jets are identical and there is 3 m between them, the overall distance between the nozzles is 2 + 3 + 2 = 7 m.

Chapter 5 Section 6 Question 17 Page 285

Solutions for Achievement Checks are in the *Teacher Resource*.

Chapter 5 Section 6 **Question 18 Page 285**

Answers may vary.

Let θ = 45º.

$$h = -\frac{5}{(v_0 \cos 45°)^2}d^2 + (\tan 45°)d$$

$$h = -\frac{5}{(v_0 \times 0.7071)^2}d^2 + (1)d$$

$$h = -\frac{10}{{v_0}^2}d^2 + d$$

The target is at the point (90, 0) on the parabola.

$$0 = -\frac{10}{{v_0}^2}(90)^2 + 90$$

$$0 - 90 = -\frac{10}{{v_0}^2}(90)^2 + 90 - 90$$

$$-90 = -\frac{10}{{v_0}^2}(90)^2$$

$$-90({v_0}^2) = -81\,000$$

$${v_0}^2 = 900$$

$$v_0 = \pm 30$$

The negative answer is not reasonable.

If the cannon's angle of elevation is 45°, the cannonball should be shot with an initial velocity of 30 m/s in order to hit a target 90 m from the cannon.

Chapter 5 Review

Chapter 5 Review **Question 1 Page 286**

a) $(x + 5)(x + 8)$
$= x^2 + 8x + 5x + 40$
$= x^2 + 13x + 40$

b) $(2x + 9)(7x – 10)$
$= 14x^2 – 20x + 63x – 90$
$= 14x^2 + 43x – 90$

c) $(x + 13)^2$
$= (x + 13) (x + 13)$
$= x^2 + 13x + 13x + 169$
$= x^2 + 26x + 169$

d) $(x – 7) (x + 7)$
$= x^2 + 7x – 7x – 49$
$= x^2 – 49$

Chapter 5 Review **Question 2 Page 286**

$(2x + 1)(8x – 2)$
$= 16x^2 – 4x + 8x – 2$
$= 16x^2 + 4x – 2$

Chapter 5 Review **Question 3 Page 286**

a) $y = 5(x + 10)^2 + 7$
$y = 5(x + 10)(x + 10) + 7$
$y = 5(x^2 + 10x + 10x + 100) + 7$
$y = 5(x^2 + 20x + 100) + 7$
$y = 5x^2 + 100x + 107$

b) $y = –0.5(x + 8)^2 + 4$
$y = –0.5(x + 8)(x + 8) + 4$
$y = –0.5(x^2 + 16x + 64) + 4$
$y = –0.5x^2 – 8x – 32 + 4$
$y = –0.5x^2 – 8x – 28$

c) $y = 9(x – 8)^2 – 4$
$y = 9(x – 8)(x – 8) – 4$
$y = 9(x^2 – 16x + 64) – 4$
$y = 9x^2 – 144x + 576 – 4$
$y = 9x^2 – 144x + 572$

d) $y = 2(x + 1)^2 – 6$
$y = 2(x + 1)(x + 1) – 6$
$y = 2(x^2 + 2x + 1) – 6$
$y = 2x^2 + 4x – 4$

Chapter 5 Review **Question 4 Page 286**

To find the *y*-intercept, substitute $x = 0$ into the equation.

a) $5(0 + 10)^2 + 7 = 507$

b) $-0.5(0 + 8)^2 + 4 = -28$

c) $9(0 - 8)^2 - 4 = 572$

d) $2(0 + 1)^2 - 6 = -4$

Chapter 5 Review **Question 5 Page 286**

Since the maximum height and the time it occurs are known, write the relation in vertex form.

$h = -4.9(t - 3)^2 + 49$

This can be expanded and simplified to standard form.

$$\begin{aligned} h &= -4.9(t^2 - 6t + 9) + 45 \\ &= -4.9t^2 + 29.4t - 44.1 + 45 \\ &= -4.9t^2 + 29.4t + 0.9 \end{aligned}$$

Comparing coefficients, the initial velocity is 29.4 m/s and the initial height is 0.9 m.

Chapter 5 Review **Question 6 Page 286**

a) $x^2 + 15x$ (Factor out the GCF, x.)
$= x(x + 15)$

b) $x^2 + 13x + 40$ (Find 2 numbers with product 40 and sum 13.)
$= (x + 5)(x + 8)$

c) $x^2 + 10x + 25$ (Find 2 numbers with product 25 and sum 10.)
$= (x + 5)(x + 5)$

d) $x^2 - 81$ (Find 2 numbers that with –81 and sum 0.)
$= (x + 9)(x - 9)$

e) $x^2 + 2x - 24$ (Find 2 numbers with product –24 and sum 2.)
$= (x + 6)(x - 4)$

f) $x^2 - 12x + 35$ (Find 2 numbers with product 35 and sum –12.)
$= (x - 5)(x - 7)$

g) $x^2 - 100$ (Find 2 numbers with product –100 and sum 0.)
$= (x + 10)(x - 10)$

h) $x^2 - 11x - 12$ (Find 2 numbers with product –12 and sum –11.)
$= (x - 12)(x + 1)$

Chapter 5 Review **Question 7 Page 286**

a) $x^2 - 4(4^2) = x^2 - 64$

b) $(30)^2 - 64 = 836$; the area of the shaded region is 836 cm^2.

Chapter 5 Review **Question 8 Page 286**

a) $4x^2 + 72x + 308$ (Factor out the GCF, 4.)
$= 4(x^2 + 18x + 77)$ (Find 2 numbers with product 77 and sum 18.)
$= 4(x + 7)(x + 11)$

b) $12x^2 + 96$ (Factor out the GCF, $12x$.)
$= 12x(x + 8)$

c) $3x^2 - 12x - 135$ (Factor out the GCF, 3.)
$= 3(x^2 - 4x - 45)$ (Find 2 numbers with product –45 and sum –4.)
$= 3(x - 9)(x + 5)$

d) $-2x^2 - 24x - 72$ (Factor out the GCF, –2.)
$= -2(x^2 + 12x + 36)$ (Find 2 numbers with product 36 and sum 12.)
$= -2(x + 6)(x + 6)$

e) $-8x^2 + 200$ (Factor out the GCF, –8.)
$= -8(x^2 - 25)$ (Find 2 numbers with product –25 and sum 0.)
$= -8(x + 5)(x - 5)$

f) $10x^2 - 80x - 200$ (Factor out the GCF, 10.)
$= 10(x^2 - 8x - 20)$ (Find 2 numbers with product –20 and sum –8.)
$= 10(x + 2)(x - 10)$

Chapter 5 Review **Question 9 Page 287**

a) $\pi r^2 - \pi(3)^2$ (Factor out the GCF, π.)
$= \pi(r^2 - 9)$ (Find 2 numbers with product –9 and sum 0.)
$= \pi(r + 3)(r - 3)$

b) $\pi(15 + 3)(15 - 3) = 216\pi \doteq 679$

The area of the shaded region is about 679 mm^2.

Chapter 5 Review **Question 10 Page 287**

a) $y = x^2 - 16x$ (Factor out the GCF, x.)
$y = x(x - 16)$

The zeros are $x = 0$ and $x = 16$.

b) $y = x^2 - 16$ (Find 2 numbers with product –16 and sum 0.)
$y = (x + 4)(x - 4)$

The zeros are at $x = 4$ and $x = -4$.

c) $y = 6x^2 + 24x - 192$ (Factor out the GCF, 6.)
$y = 6(x^2 + 4x - 32)$ (Find 2 numbers with product –32 and sum 4.)
$y = 6(x + 8)(x - 4)$

The zeros are at $x = -8$ and $x = 4$.

Chapter 5 Review **Question 11 Page 287**

a) $y = 3(x - 1)^2 - 147$ (Expand and simplify.)
$y = 3(x - 2x + 1) - 147$
$y = 3x^2 - 6x + 3 - 147$
$y = 3x^2 - 6x - 144$ (standard form)
$y = 3(x^2 - 2x - 48)$ (Find 2 numbers with product –18 and sum –2.)
$y = 3(x - 8)(x + 6)$ (vertex form)

The zeros are at $x = 8$ and $x = -6$.

b) $y = -4(x + 6)^2 + 36$ (Expand and simplify.)
$y = -4(x^2 + 12x + 36) + 36$
$y = -4x^2 - 48x - 144 + 36$
$y = -4x^2 - 48x - 108$ (standard form)
$y = -4(x^2 + 12x + 27)$ (Find 2 numbers with product 27 and sum 12.)
$y = -4(x + 3)(x + 9)$ (vertex form)

The zeros are at $x = -3$ and $x = -9$.

Chapter 5 Review **Question 12 Page 287**

a) $h = -0.1d^2 + 0.5d + 0.6$ (Factor out the GCF, –0.1.)
$h = -0.1(d^2 - 5d - 6)$ (Find 2 numbers with product –6 and sum –5.)
$h = -0.1(d^2 - 6)(d + 1)$

The zeros are at $d = -1$ and $d = 6$.

b) $d = 6$ is the horizontal distance from the kicker to landing; $d = -1$ does not have a meaning in this context.

Chapter 5 Review **Question 13 Page 287**

a) $y = x^2 + 16x + 39$ (Find 2 numbers with product 39 and sum 16.)
$y = (x + 3)(x + 13)$

$x = –3$ and $x = –13$ are the zeros.

The parabola opens up, so there is a minimum.
The vertex lies on the axis of symmetry that is halfway between the zeros at $x = –8$.
$y = (–8)^2 + 16(–8) + 39 = –25$

The vertex is (–8, –25). The minimum value is –25.

b) $y = 5x^2 – 50x – 120$ (Factor out the GCF, 5.)
$y = 5(x^2 – 10x – 24)$ (Find 2 numbers with product –24 and sum –10.)
$y = 5(x – 12)(x + 2)$

$x = 12$ and $x = –2$ are the zeros.

The parabola opens up, so there is a minimum.
The vertex lies on the axis of symmetry that is halfway between the zeros at $x = 5$.
$y = 5(5)^2 – 50(5) – 120 = –245$

The vertex is (5, –245). The minimum value is –245.

c) $y = –2x^2 – 28x + 64$ (Factor out the GCF, –2.)
$y = –2(x^2 + 14x – 32)$ (Find 2 numbers with product –32 and sum 14.)
$y = –2(x – 2)(x + 16)$

$x = 2$ and $x = –16$ are the zeros.

The parabola opens down, so there is a maximum.
The vertex lies on the axis of symmetry that is halfway between the zeros at $x = –7$.
$y = –2(–7)^2 – 28(–7) + 64 = 162$

The vertex is (–7, 162). The maximum value is 162.

d) $y = 6x^2 + 36x –42$ (Factor out the GCF, 6.)
$y = 6(x^2 + 6x –7)$ (Find 2 numbers with product –7 and sum 6.)
$y = 5(x – 1)(x + 7)$

$x = 1$ and $x = –7$ are the zeros.

The parabola opens up, so there is a minimum.
The vertex lies on the axis of symmetry that is halfway between the zeros at $x = –3$.
$y = 6(–3)^2 + 36(–3) – 42 = –96$

The vertex is (–3, –96). The minimum value is –96.

Chapter 5 Review Question 14 Page 287

a) The area of the border equals the area of the large rectangle subtract that of the small rectangle.
The length of the larger rectangle is: $x + 16 + x = 2x + 16$
The width of the larger rectangle is: $x + 14 + x = 2x + 14$
Area of small rectangle: (16)(14)

Area of border: $(2x + 16)(2x + 14) - (16)(14) = 4x^2 + 28x + 32x + 224 - 224 = 4x^2 + 60x$

b) $4x^2 + 60x = 216$
$4x^2 + 60x - 216 = 0$ (Factor out the GCF, 4.)
$4(x^2 + 15x - 54) = 0$ (Find 2 numbers with product –54 and sum 15.)
$4(x - 3)(x + 18) = 0$
The zeros are at $x = 3$ and $x = -18$, but –18 is not a reasonable width for the border.

The width of the border is 3 m.

Chapter 5 Review Question 15 Page 287

a) The height of the ledge is modelled by $d = 0$.
$h = -0.3(0)^2 + 1.2(0) + 1.5 = 1.5$

The height of the ledge is 1.5 m.

b) To find her landing point, find the zeros of the relation.
$h = -0.3d^2 + 1.2d + 1.5$ (Factor out the GCF, –0.3.)
$h = -0.3(d^2 - 4d - 5)$ (Find 2 numbers with product –5 and sum –4.)
$h = -0.3(d - 5)(d + 1)$
The zeros are at $d = -1$ and $d = 5$.

The rider was 5 m from the ledge when she landed.

Chapter 5 Practice Test

Chapter 5 Practice Test **Question 1 Page 288**

D
$(2x + 9)(2x + 9) = 4x^2 + 18x + 18x + 81 = 4x^2 + 36x + 81$

Chapter 5 Practice Test **Question 2 Page 288**

B
$(5x – 7)(3x + 5) = 15x^2 + 25x – 21x – 35 = 15x^2 + 4x – 35$

Chapter 5 Practice Test **Question 3 Page 288**

C
$y = 5(x – 6)^2 – 20$
$y = 5(x – 6)(x – 6) – 20$
$y = 5(x^2 – 12x + 36) – 20$
$y = 5x^2 – 60x + 180 – 20$
$y = 5x^2 – 60x + 160$

Chapter 5 Practice Test **Question 4 Page 288**

B (Find 2 numbers with product –20 and sum –8.)

Chapter 5 Practice Test **Question 5 Page 288**

A (The zeros are $x = 7$ and $x = –17$. The axis of symmetry is halfway in between at $x = –5$.)

Chapter 5 Practice Test **Question 6 Page 288**

D
$y = 5x^2 – 1125$ (Factor out the GCF, 5.)
$y = 5(x^2 – 225)$ (Find 2 numbers with product –225 and sum 0.)
$y = 5(x – 15)(x + 15)$
The zeros are $x = 15$ and $x = –15$.

Chapter 5 Practice Test **Question 7 Page 288**

C
$y = 4x^2 – 44x – 240$ (Factor out the GCF, 4.)
$y = 4(x^2 – 11x – 60)$ (Find 2 numbers with product –60 and sum –11.)
$y = 4(x – 15)(x + 4)$

Chapter 5 Practice Test **Question 8 Page 288**

a) Area = length × width = $(6x + 8)(3x – 10)$
$(6x + 8)(3x – 10) = 18x^2 – 60x + 24x – 80 = 18x^2 – 36x – 80$

b) $18(5)^2 – 36(5) – 80 = 190$; the area of the rectangle is 190 cm^2.

Chapter 5 Practice Test **Question 9 Page 288**

a) $y = 13(x + 7)^2 + 11$ (Expand and simplify.)
$y = 13(x + 7)(x + 7) + 11$
$y = 13(x^2 + 14x + 49) + 11$
$y = 13x^2 + 182x + 637 + 11$
$y = 13x^2 + 182x + 648$ (standard form)

b) $y = –4(x – 3)^2 + 16$ (Expand and simplify.)
$y = –4(x – 3)(x – 3) + 16$
$y = –4(x^2 – 6x + 9) + 16$
$y = –4x^2 + 24x – 36 + 16$
$y = –4x^2 + 248x – 20$ (standard form)

c) $y = 5.6(x – 1.2)^2 – 8.2$ (Expand and simplify.)
$y = 5.6(x – 1.2)(x – 1.2) – 8.2$
$y = 5.6(x^2 – 1.2x – 1.2x + 1.44) – 8.2$
$y = 5.6(x^2 –2.4x + 1.44) – 8.2$
$y = 5.6x^2 – 13.44x + 8.064) – 8.2$
$y = 5.6x^2 – 13.44x – 0.136$ (standard form)

Chapter 5 Practice Test **Question 10 Page 288**

a) $y = x^2 – 2x – 35$ (Find 2 numbers with product –35 and sum –2.)
$y = 4(x – 7)(x + 5)$
The zeros are $x = 7$ and $x = –5$.

b) $y = 3x^2 + 12x – 96$ (Factor out the GCF, 3.)
$y = 3(x^2 + 4x – 32)$ (Find 2 numbers with product –32 and sum 4.)
$y = 3(x + 8)(x – 4)$
The zeros are $x = 4$ and $x = –8$.

c) $y = –2.5x^2 – 40x – 70$ (Factor out the GCF, –2.5.)
$y = –2.5(x^2 + 16x + 28)$ (Find 2 numbers with product 28 and sum 16.)
$y = –2.5(x + 2)(x + 14)$
The zeros are $x = –2$ and $x = –14$.

Chapter 5 Practice Test **Question 11 Page 289**

a) This situation is modelled by the h-intercept, when $d = 0$.
$h = 0.0025(d – 100)^2 + 25 = 0.0025(0 – 100)^2 + 25 = 25 + 25 = 50$

The cable meets the tower at a height of 50 m.

b) The least height is modelled by the second coordinate of the vertex.
The curve for the relation $h = 0.0025(d – 100)^2 + 25$ is a parabola that opens upward with vertex at (100, 25).

The least height of the cable above the ground is 25 m.

Chapter 5 Practice Test **Question 12 Page 289**

a) The height of the platform is modelled by $d = 0$.
$h = -0.7(0)^2 + 0.7(0) + 4.2 = 4.2$

The height of the platform is 4.2 m.

b) The acrobat's landing is modelled by a zero of the relation.
$h = -0.7d^2 + 0.7d + 4.2$ (Factor out the GCF, –0.7.)
$h = -0.7(d^2 - 1d - 6)$ (Find 2 numbers with product –6 and sum –1.)
$h = -0.7(d - 3)(d + 2)$
The zeros are $d = 3$ and $d = -2$. (–2 is an unreasonable answer since distance must be positive.)

The acrobat landed 3 m from the edge of the platform.

c) The axis of symmetry is halfway between the two zeros $d = 3$ and $d = -2$.
The equation of the axis of symmetry is $d = 0.5$.
$h = -0.7(0.5)^2 + 0.7(0.5) + 4.2$
$h = -0.175 + 0.35 + 4.2$
$h = 4.375$
The vertex is (0.5, 4.375).

The acrobat's maximum height was 4.375 m above the stage.