Quadratic Applications and Modeling

Name: _____	Date: _____	Score: _____ / 24

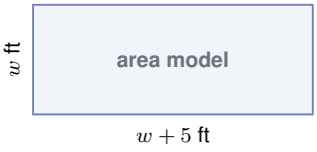
Quick Review

Quadratic models are useful when a situation has a maximum, a minimum, an area made from two changing dimensions, or a path that curves like a parabola. The **vertex** answers highest, lowest, or best-value questions. The **zeros** answer break-even, landing-time, and ground-level questions. Always read the meaning of the variable before choosing an answer, and reject values that do not make sense in the situation.

PRACTICE

Read each application carefully and answer the question.

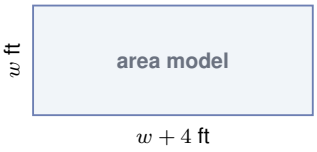
1. A rectangular stage has area 84 ft^2. Its length is 5 ft more than its width. Find the width.



Width	Length	Area equation
w	$w+5$	$w(w+5)=84$

Answer: _____

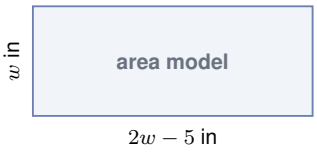
2. A garden has area 96 ft^2. Its length is 4 ft more than its width. Find the dimensions.



Width	Length	Area equation
w	$w+4$	$w(w+4)=96$

Answer: _____

3. A poster has area 150 in^2. Its length is 5 in less than twice its width. Find the width.



Width	Length	Area equation
w	$2w-5$	$w(2w-5)=150$

Answer: _____

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4. Two consecutive positive integers have product 72. Find the integers.

Smaller integer	Next integer	Product
n	$n+1$	$n(n+1)=72$

Answer: _____

5. A number is multiplied by a number 6 greater than itself, and the product is 16. Find all possible values.

Number	Number plus 6	Product
x	$x+6$	$x(x+6)=16$

Answer: _____

6. A ball's height in feet is $h(t)=-16t^2+48t+4$. Find the starting height.

Time	0	1	2
Height		36	36

What starting height means
Use $t=0$ because the ball has just been thrown.

Answer: _____

7. A rocket's height in feet is $h(t)=-16t^2+64t+80$. When does it land?

Time	0	2	4	5
Height	80	144	80	

Answer: _____

8. A ball's height in feet is $h(t)=-16t^2+32t$. Find the maximum height.

Time	0	1	2
Height	0		0

Vertex time
$t=-\dfrac{b}{2a}=-\dfrac{32}{2(-16)}=1$

Answer: _____

9. A store's revenue from selling one item is modeled by $R(p)=-2p^2+40p$, where p is the price in dollars. Find the price that gives the greatest revenue.

Price p	6	8	10	12	14
Revenue $R(p)$	168	192		192	168

Answer: _____

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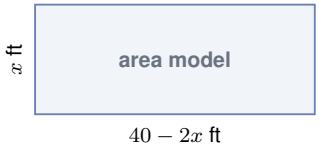
10. Profit is modeled by $P(x) = -x^2 + 12x - 20$. Find the break-even values.

x	0	2	6	10	12
$P(x)$	-20		16		-20

Answer: _____

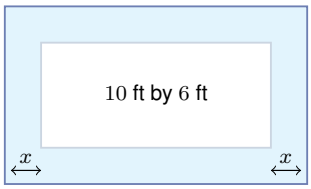
11. A rectangular animal pen uses a wall as one side. The area is $A = x(40-2x)$, where x is the width. Find the width for maximum area.



Width x	5	10	15
Area A	150		150

Answer: _____

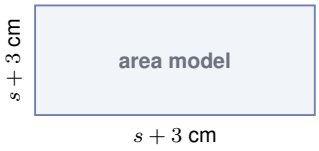
12. A 10 ft by 6 ft garden gets a border of width x around all sides. The total area is 96 ft^2. Find x.



Outer length	Outer width	Area equation
$10 + 2x$	$6 + 2x$	$(10 + 2x)(6 + 2x) = 96$

Answer: _____

13. A square's side length grows from s cm to $s + 3$ cm. The new area is 121 cm^2. Find the original side length.



New side	New area
$s + 3$	$(s + 3)^2 = 121$

Answer: _____

14. A ball's height in meters is $h(t) = -5t^2 + 20t + 1$. Find the maximum height.

Time	0	1	2	3	4
Height	1	16		16	1

Answer: _____

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15. A football's height in feet is $h(t) = -16t^2 + 96t$. How long is it in the air?

Time	0	3	6
Height	0	144	

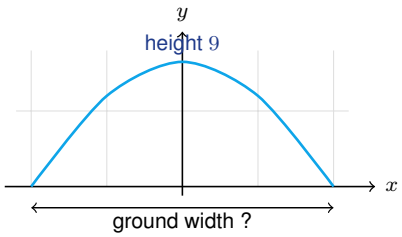
Answer: _____

16. A company models profit with $P(x) = -0.5x^2 + 30x - 200$. Find the value of x that maximizes profit.

x	20	30	40
$P(x)$	200		200

Answer: _____

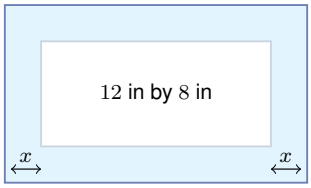
17. A bridge arch is modeled by $y = -\frac{1}{25}x^2 + 9$. Find its ground-level width.



Ground level means
Set $y = 0$ and find both x-intercepts.

Answer: _____

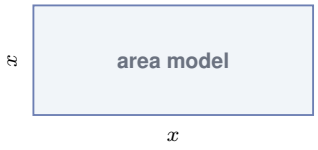
18. An 8 in by 12 in photo gets a frame of width x around all sides. The total area is 192 in^2. Find x.



Outer length	Outer width	Area equation
$12 + 2x$	$8 + 2x$	$(12 + 2x)(8 + 2x) = 192$

Answer: _____

19. A square's area equals its perimeter. Find the positive side length x.



Area	Perimeter	Equation
x^2	$4x$	$x^2 = 4x$

Answer: _____

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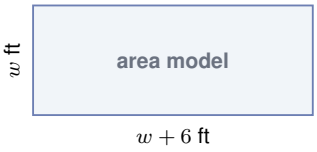
20. A drone's height in meters is $h(t) = -4.9t^2 + 19.6t + 14.7$. Find the maximum height.

Time	0	1	2	3	4
Height	14.7	29.4		29.4	14.7

Answer: _____

Word Problems

21. A mural is painted on a rectangular wall. The area is 160 ft^2, and the length is 6 ft more than the width. Find the mural's dimensions.



Width	Length	Area equation
w	$w + 6$	$w(w + 6) = 160$

Answer: _____

22. A theater models ticket revenue with $R(p) = -25p^2 + 600p$, where p is the ticket price in dollars. Find the price that gives maximum revenue.

Price p	8	10	12	14	16
Revenue	3200	3500		3500	3200

Answer: _____

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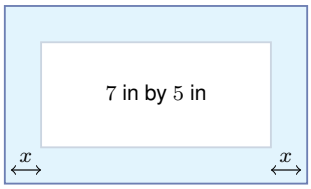
Word Problems

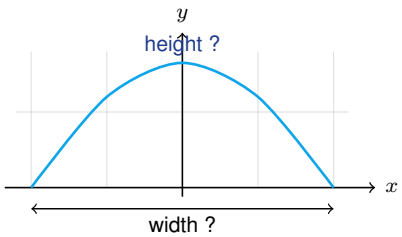
23. A 5 in by 7 in photo has a frame of width x around all sides. The total area is 99 in^2. Find the border width.



Outer length	Outer width	Area equation
$7+2x$	$5+2x$	$(7+2x)(5+2x)=99$

Answer: _____

24. A bridge arch is modeled by $y=-\frac{1}{16}x^2+25$, with the road at $y=0$. Find the arch height and the ground-level width.



Feature	What it tells you
Vertex	maximum height
x-intercepts	ground-level width

Answer: _____

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Answer Keys

1. 7 ft
2. 8 ft by 12 ft
3. 10 in
4. 8 and 9
5. 2 or -8
6. 4 ft
7. 5 sec
8. 16 ft
9. \$10
10. $x = 2$ and $x = 10$
11. 10 ft
12. 1 ft
13. 8 cm
14. 21 m
15. 6 sec
16. $x = 30$
17. 30 units
18. 2 in
19. $x = 4$
20. 34.3 m
21. 10 ft by 16 ft
22. \$12
23. 2 in
24. 25 units high, 40 units wide

Step-by-Step Tutor Notes

1. The rectangle gives $w(w+5) = 84$. After factoring, $(w+12)(w-7) = 0$. A width cannot be negative, so $w = 7$ ft.
2. Set up $w(w+4) = 96$. This factors as $(w+12)(w-8) = 0$, so the usable width is 8 ft and the length is 12 ft.
3. The model is $w(2w-5) = 150$. Solving $2w^2 - 5w - 150 = 0$ gives $w = 10$ or $w = -7.5$. Use 10 in.
4. Let the smaller integer be n. Then $n(n+1) = 72$, so $(n+9)(n-8) = 0$. The positive pair is 8 and 9.
5. The equation is $x^2 + 6x = 16$. Move everything to one side: $x^2 + 6x - 16 = 0 = (x+8)(x-2)$. So $x = 2$ or $x = -8$.
6. The starting height is the value at $t = 0$. $h(0) = -16(0)^2 + 48(0) + 4 = 4$ ft.
7. Landing means height 0. Set $-16t^2 + 64t + 80 = 0$, which leads to $(t-5)(t+1) = 0$. The positive time is 5 sec.
8. The vertex gives the maximum. The vertex time is $t = 1$, and $h(1) = -16 + 32 = 16$ ft.
9. The table is symmetric around $p = 10$, and the vertex formula also gives $p = -\frac{40}{2(-2)} = 10$. The best price is \$10.
10. Break-even means profit is 0. Solve $-x^2 + 12x - 20 = 0$, which gives $x = 2$ and $x = 10$.
11. The area model is $A = -2x^2 + 40x$. Its vertex is at $x = -\frac{40}{2(-2)} = 10$, so the width is 10 ft.
12. The border is added to both ends of each dimension. The model simplifies to $x^2 + 8x - 9 = 0 = (x+9)(x-1)$, so $x = 1$ ft.
13. The new side is $s+3$. Since the area is 121, $(s+3)^2 = 121$, so $s+3 = 11$ and $s = 8$ cm.
14. The vertex time is $t = -\frac{20}{2(-5)} = 2$. Then $h(2) = -20 + 40 + 1 = 21$ m.
15. The ball is in the air until it returns to height 0. $-16t^2 + 96t = -16t(t-6)$, so the second zero is 6 sec.
16. The values are symmetric around the vertex. The vertex formula gives $x = -\frac{30}{2(-0.5)} = 30$.
17. At ground level, $0 = -\frac{1}{25}x^2 + 9$. Then $x^2 = 225$, so $x = -15$ and $x = 15$. The full width is 30.
18. The full framed photo has dimensions $12 + 2x$ by $8 + 2x$. The equation simplifies to $(x+12)(x-2) = 0$, so $x = 2$ in.
19. Area equals perimeter gives $x^2 = 4x$. Then $x(x-4) = 0$. The positive side length is 4.
20. The vertex time is $t = -\frac{19.6}{2(-4.9)} = 2$. Substitute to get $h(2) = 34.3$ m.
21. Let the width be w. Then $w(w+6) = 160$, so $(w+16)(w-10) = 0$. Use $w = 10$, and the length is 16 ft.
22. The maximum is at the vertex. $p = -\frac{600}{2(-25)} = 12$, so the best price is \$12.
23. Use $(5+2x)(7+2x) = 99$. This simplifies to $x^2 + 6x - 16 = 0 = (x+8)(x-2)$. The border is 2 in.
24. The vertex is at $(0, 25)$, so the height is 25. For ground level, set $y = 0$ to get $x = \pm 20$, so the full width is 40 units.

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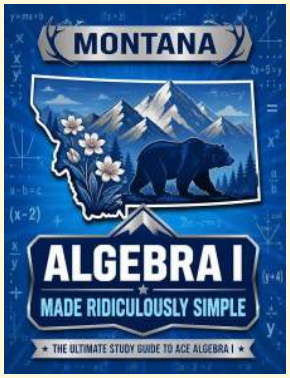

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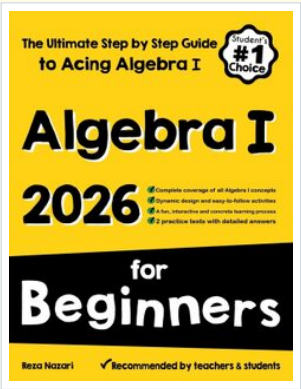

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