

# Graphing Quadratic Functions

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 30

## Quick Review

A **quadratic function**  $y = ax^2 + bx + c$  graphs as a **parabola**. Key features: the **vertex** is the highest or lowest point; the **axis of symmetry** is the vertical line through the vertex, with equation  $x = -\frac{b}{2a}$ . The parabola opens **up** when  $a > 0$  (vertex is the minimum) and **down** when  $a < 0$  (vertex is the maximum). The **y-intercept** is  $c$  (set  $x = 0$ ). The **x-intercepts** (zeros) come from solving  $ax^2 + bx + c = 0$  — they're where the parabola crosses the  $x$ -axis. To graph: find the vertex, plot a few points on each side, connect with a smooth curve.

## PRACTICE

Find key features of each quadratic.

- |                               |       |   |       |
|-------------------------------|-------|---|-------|
| 1. $y = x^2$                  | _____ | 11. $y = (x + 1)^2 - 4$ ; vertex                | _____ |
| 2. $y = x^2 + 5$              | _____ | 12. $y = x^2$ ; is (2, 4) on graph?             | _____ |
| 3. $y = (x - 3)^2$            | _____ | 13. $y = -(x - 1)^2 + 3$ ; vertex, direction    | _____ |
| 4. $y = -x^2$                 | _____ | 14. $y = x^2 - 9$ ; x-intercepts                | _____ |
| 5. $y = x^2 - 6x$             | _____ | 15. $y = 2x^2$ ; wider or narrower than $x^2$ ? | _____ |
| 6. $y = 2x^2 - 8x + 1$        | _____ | 16. $y = \frac{1}{2}x^2$ ; wider or narrower?   | _____ |
| 7. $y = x^2 + 2x - 3$ ; y-int | _____ | 17. $y = x^2 + 4x + 4$ ; vertex                 | _____ |
| 8. $y = -x^2 + 4$ ; opens?    | _____ | 18. $y = -2x^2 + 8x$ ; max value                | _____ |
| 9. $y = 3x^2 + 6x$ ; vertex   | _____ | 19. $y = x^2 - 1$ ; zeros                       | _____ |
| 10. $y = x^2 - 4x + 4$        | _____ | 20. $y = (x - 5)^2 + 2$ ; vertex                | _____ |

## VISUAL PRACTICE

Use the graph, table, chart, or diagram to answer the question.

21. Use the table and graph to identify the vertex.

$x$	-1	0	1	2	3
$y$	0	-3	-4	-3	0



Answer: \_\_\_\_\_

22. Use the graph to identify the vertex.



Answer: \_\_\_\_\_



## ◆ Word Problems

23. A ball is tossed straight up from the ground, and its height is modeled by  $h(t) = -16t^2 + 32t$ . Find when it reaches its peak and how high it is.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

24. A small business models profit by  $P(x) = -x^2 + 10x - 9$  thousand dollars, where  $x$  is hundreds of units sold. How many units give the maximum profit, and what is that profit?

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

25. A model rocket is launched from a platform, and its height in feet is  $h(t) = -16t^2 + 64t + 80$ . When does it hit the ground?

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

26. A parabolic bridge follows  $y = -\frac{1}{100}x^2 + 50$  where  $x$  is horizontal distance. Find the maximum height and the width at ground level.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

27. A fountain spray is modeled by  $y = -2(x - 3)^2 + 18$ , where  $x$  is horizontal distance in feet. Find the highest point and the axis of symmetry.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

28. A ball's height is  $h(t) = -5t^2 + 20t + 1$  meters. Find the time and height at the peak.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

29. A small business models weekly profit by  $P(x) = -(x - 6)^2 + 49$ , where  $x$  is hundreds of items sold. What sales level gives maximum profit?

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

30. A parabola has vertex  $(-4, -2)$  and opens upward. Which is less: the value at  $x = -4$  or at  $x = 0$ ?

Model: \_\_\_\_\_

Answer: \_\_\_\_\_



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## Answer Keys

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. vertex (0, 0)</li> <li>2. (0, 5)</li> <li>3. (3, 0)</li> <li>4. opens down, vertex (0, 0)</li> <li>5. <math>x = 3</math></li> <li>6. <math>x = 2</math></li> <li>7. (0, -3)</li> <li>8. down</li> <li>9. (-1, -3)</li> <li>10. (2, 0)</li> <li>11. (-1, -4)</li> <li>12. yes</li> <li>13. (1, 3), down</li> <li>14. <math>\pm 3</math></li> <li>15. narrower</li> </ol> | <ol style="list-style-type: none"> <li>16. wider</li> <li>17. (-2, 0)</li> <li>18. <math>y = 8</math></li> <li>19. <math>\pm 1</math></li> <li>20. (5, 2)</li> <li>21. (1, -4)</li> <li>22. (1, -4)</li> <li>23. <math>t = 1</math> sec, <math>h = 16</math> ft</li> <li>24. \$16,000 at 500 units</li> <li>25. <math>t = 5</math> sec</li> <li>26. 50 ft, width <math>\approx 141.4</math> ft</li> <li>27. highest point (3, 18), axis <math>x = 3</math></li> <li>28. <math>t = 2</math> sec, <math>h = 21</math> m</li> <li>29. 600 items</li> <li>30. the value at <math>x = -4</math></li> </ol> |
|---|---|

### Step-by-Step Tutor Notes

1. Look for the key feature the question asks about, such as a zero, intercept, or vertex. Standard parabola: vertex at origin. That leads to vertex (0, 0).
2. Look for the key feature the question asks about, such as a zero, intercept, or vertex. Shift up 5: vertex at (0, 5). That leads to (0, 5).
3. First identify the feature of the graph or equation that matches the wording of the question. Shift right 3: vertex at (3, 0). That leads to (3, 0).
4. Use the structure of the expression to find the important point, then check that it fits the context. Negative coefficient flips it; vertex is now a max. That leads to opens down, vertex (0, 0).
5. Focus on the main idea of the problem, then simplify carefully. Axis:  $-\frac{-6}{2} = 3$ . So the answer is  $x = 3$ .
6. This is a good place to slow down, check the notation, and simplify cleanly. Axis:  $-\frac{-8}{4} = 2$ . So the answer is  $x = 2$ .
7. Take it one clear step at a time and keep the original question in mind.  $y$ -int is the constant  $c = -3$ . So the answer is (0, -3).
8. Focus on the main idea of the problem, then simplify carefully.  $a = -1 < 0$ . So the answer is down.
9. Start with the definition the problem is testing, then apply it directly.  $x = -\frac{3}{6} = -1$ .  $y = 3(1) + 6(-1) = -3$ . So the answer is (-1, -3).
10. Start with the definition the problem is testing, then apply it directly.  $x = 2$ ,  $y = 4 - 8 + 4 = 0$ . (This is also  $(x - 2)^2$ ). So the answer is (2, 0).
11. First identify the feature of the graph or equation that matches the wording of the question. Vertex form  $a(x - h)^2 + k$  gives vertex  $(h, k) = (-1, -4)$ . That leads to (-1, -4).
12. Start with the definition the problem is testing, then apply it directly.  $2^2 = 4$ .  $\checkmark$ . So the answer is yes.
13. Use the structure of the expression to find the important point, then check that it fits the context. Vertex form: vertex (1, 3).  $a = -1 < 0 \rightarrow$  opens down. That leads to (1, 3), down.
14. Start with the definition the problem is testing, then apply it directly.  $x^2 = 9$ . So the answer is  $\pm 3$ .
15. For a table question, slow down and locate the exact row, column, or cell before calculating.  $|a| > 1$  stretches vertically (narrows). This gives narrower.
16. Focus on the main idea of the problem, then simplify carefully.  $|a| < 1$  compresses (widens). So the answer is wider.
17. Start with the definition the problem is testing, then apply it directly.  $x = -2$ ,  $y = 4 - 8 + 4 = 0$ . So the answer is (-2, 0).
18. Focus on the main idea of the problem, then simplify carefully.  $x = 2$ ,  $y = -8 + 16 = 8$ . So the answer is  $y = 8$ .
19. Start with the definition the problem is testing, then apply it directly.  $x^2 = 1$ . So the answer is  $\pm 1$ .
20. Look for the key feature the question asks about, such as a zero, intercept, or vertex. Vertex form. That leads to (5, 2).
21. Look for the key feature the question asks about, such as a zero, intercept, or vertex. The smallest  $y$ -value is -4 at  $x = 1$ , so the vertex is (1, -4). That leads to (1, -4).
22. Use the structure of the expression to find the important point, then check that it fits the context. The lowest point of the parabola is (1, -4), so that is the vertex. That leads to (1, -4).
23. Axis:  $t = -\frac{-32}{2} = 1$ .  $h(1) = -16 + 32 = 16$  ft. Peak at 1 sec, height 16 ft.
24. Vertex  $x = -\frac{10}{2} = 5$ .  $P(5) = -25 + 50 - 9 = 16$  (thousand). Max profit \$16K at 500 units.
25.  $h = 0$ :  $-16t^2 + 64t + 80 = 0$ , divide by -16:  $t^2 - 4t - 5 = 0 \Rightarrow (t - 5)(t + 1) = 0$ . Positive answer:  $t = 5$ .
26. Vertex at  $x = 0$ :  $y = 50$  (max height). Zeros:  $x^2 = 5000 \Rightarrow x = \pm\sqrt{5000} \approx 70.7$ . That means the bridge touches the ground about 70.7 ft left and right of center, so the total ground-level width is about 141.4 ft.
27. The equation is already in vertex form. The vertex is (3, 18), so the maximum height is 18 ft and the axis of symmetry is  $x = 3$ .
28. The vertex time is  $t = -\frac{20}{2(-5)} = 2$ . Then  $h(2) = -5(4) + 40 + 1 = 21$ , so the peak is 21 m at 2 sec.
29. The vertex is (6, 49). Since  $x$  is measured in hundreds of items,  $x = 6$  means 600 items.
30. An upward-opening parabola has a minimum at its vertex. Since the vertex is at  $x = -4$ , that value is less than values away from the vertex, such as the value at  $x = 0$ .



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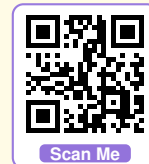
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