

# Characteristics of Quadratic Functions

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 26

## Quick Review

Three forms of a quadratic, each highlighting different features: **Standard form**  $y = ax^2 + bx + c$  shows the  $y$ -intercept ( $c$ ). **Vertex form**  $y = a(x - h)^2 + k$  shows the vertex  $(h, k)$  directly. **Factored form**  $y = a(x - r_1)(x - r_2)$  shows the zeros (roots)  $r_1$  and  $r_2$ . **Domain** of any quadratic is all real numbers. **Range**: if opening up,  $y \geq k$  (the vertex  $y$ ); if opening down,  $y \leq k$ . The parabola is **increasing** on one side of the axis of symmetry and **decreasing** on the other — the vertex is where it switches.

## PRACTICE

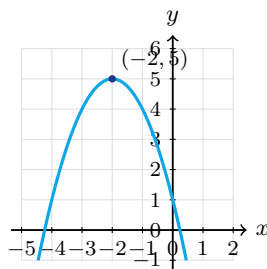
Identify features of each quadratic.

- |                                           |       |                                            |       |
|-------------------------------------------|-------|--------------------------------------------|-------|
| 1. $y = (x - 3)^2 + 2$ ; vertex           | _____ | 11. $y = -x^2$ ; range                     | _____ |
| 2. $y = (x + 1)^2 - 5$ ; vertex           | _____ | 12. $y = x^2 - 6x + 9$ ; vertex            | _____ |
| 3. $y = 2(x - 1)^2 + 4$ ; range           | _____ | 13. $y = x^2 + 1$ ; zeros                  | _____ |
| 4. $y = -(x + 2)^2 + 7$ ; range           | _____ | 14. $y = x^2 - 1$ ; zeros                  | _____ |
| 5. $y = x^2 - 9$ ; zeros                  | _____ | 15. $y = (x - 2)^2$ ; increasing on        | _____ |
| 6. $y = (x - 2)(x + 5)$ ; zeros           | _____ | 16. $y = -(x - 1)^2$ ; max value           | _____ |
| 7. $y = x^2 + 4x$ ; vertex                | _____ | 17. $y = 3(x - 4)^2 + 1$ ; vertex, min/max | _____ |
| 8. $y = -x^2 + 6x - 5$ ; find the maximum | _____ | 18. $y = x^2 - 2x + 1$ ; vertex            | _____ |
| 9. $y = x^2$ ; domain                     | _____ | 19. $y = 2(x + 3)(x - 1)$ ; zeros          | _____ |
| 10. $y = x^2$ ; range                     | _____ | 20. $y = x^2 - 25$ ; vertex, zeros         | _____ |

## VISUAL PRACTICE

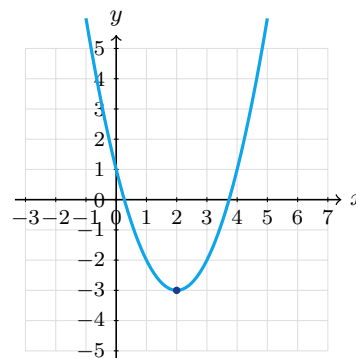
Use the graph, table, chart, or diagram to answer the question.

21. The parabola has vertex  $(-2, 5)$  and opens down. What is its maximum value?



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

22. The parabola opens up and has vertex  $(2, -3)$ . What is the minimum value?



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



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## ◆ Word Problems

23. A soccer ball is kicked upward, and its height is modeled by  $h(t) = -16t^2 + 48t$ . Find the maximum height.

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

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

24. A parabolic arch is modeled by  $y = -x^2 + 16$ , where ground level is  $y = 0$ . Find the arch's ground-level width and maximum height.

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

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

25. A fundraiser models revenue with  $R(p) = -2p^2 + 40p$ , where  $p$  is the ticket price in dollars. What ticket price maximizes revenue?

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

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

26. A diver jumps with height  $h(t) = -16t^2 + 8t + 24$ . When does the diver hit water?

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

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



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## Answer Keys

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> <li>1. <math>(3, 2)</math></li> <li>2. <math>(-1, -5)</math></li> <li>3. <math>y \geq 4</math></li> <li>4. <math>y \leq 7</math></li> <li>5. <math>\pm 3</math></li> <li>6. <math>2, -5</math></li> <li>7. <math>(-2, -4)</math></li> <li>8. <math>y = 4</math> at <math>x = 3</math></li> <li>9. <math>\mathbb{R}</math></li> <li>10. <math>y \geq 0</math></li> <li>11. <math>y &lt; 0</math></li> <li>12. <math>(3, 0)</math></li> <li>13. none</li> </ol> | <ol style="list-style-type: none"> <li>14. <math>\pm 1</math></li> <li>15. <math>x &gt; 2</math></li> <li>16. 0</li> <li>17. <math>(4, 1)</math>, min</li> <li>18. <math>(1, 0)</math></li> <li>19. <math>-3, 1</math></li> <li>20. <math>(0, -25)</math>, <math>\pm 5</math></li> <li>21. 5</li> <li>22. <math>-3</math></li> <li>23. 36 ft</li> <li>24. width 8, height 16</li> <li>25. <math>p = \\$10</math>, <math>R = \\$200</math></li> <li>26. <math>t = \frac{3}{2}</math> sec</li> </ol> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Step-by-Step Tutor Notes

1. First identify the feature of the graph or equation that matches the wording of the question. Vertex form. That leads to  $(3, 2)$ .
2. Focus on the main idea of the problem, then simplify carefully.  $h = -1$ ,  $k = -5$ . So the answer is  $(-1, -5)$ .
3. Focus on the main idea of the problem, then simplify carefully. Opens up, min 4. So the answer is  $y \geq 4$ .
4. Take it one clear step at a time and keep the original question in mind. Opens down, max 7. So the answer is  $y \leq 7$ .
5. Start with the definition the problem is testing, then apply it directly.  $x^2 = 9$ . So the answer is  $\pm 3$ .
6. Use the structure of the expression to find the important point, then check that it fits the context. Factored form: zeros are 2 and  $-5$ . That leads to 2,  $-5$ .
7. Use the clue in the question first, then let the arithmetic finish the job.  $x = -2$ ,  $y = 4 - 8 = -4$ . So the answer is  $(-2, -4)$ .
8. Use the clue in the question first, then let the arithmetic finish the job.  $x = -\frac{6}{-2} = 3$ ,  $y = -9 + 18 - 5 = 4$ . So the answer is  $y = 4$  at  $x = 3$ .
9. This is a good place to slow down, check the notation, and simplify cleanly. All real  $x$  allowed. So the answer is  $\mathbb{R}$ .
10. Take it one clear step at a time and keep the original question in mind.  $x^2$  is always nonneg. So the answer is  $y \geq 0$ .
11. Start with the definition the problem is testing, then apply it directly. Negated. So the answer is  $y < 0$ .
12. Look for the key feature the question asks about, such as a zero, intercept, or vertex.  $= (x - 3)^2$ , vertex  $(3, 0)$ . That leads to  $(3, 0)$ .
13. This is a good place to slow down, check the notation, and simplify cleanly.  $x^2 = -1$  has no real solution. So the answer is none.
14. Start with the definition the problem is testing, then apply it directly.  $x^2 = 1$ . So the answer is  $\pm 1$ .
15. Use the structure of the expression to find the important point, then check that it fits the context. To the right of vertex, parabola goes up. That leads to  $x > 2$ .
16. First identify the feature of the graph or equation that matches the wording of the question. Vertex  $(1, 0)$ , opens down. That leads to 0.
17. This is a good place to slow down, check the notation, and simplify cleanly.  $a = 3 > 0$  opens up, so  $(4, 1)$  is the minimum. So the answer is  $(4, 1)$ , min.
18. This is a good place to slow down, check the notation, and simplify cleanly.  $= (x - 1)^2$ . So the answer is  $(1, 0)$ .
19. Use the structure of the expression to find the important point, then check that it fits the context. From factored form. That leads to  $-3, 1$ .
20. Use the structure of the expression to find the important point, then check that it fits the context. Vertex at  $y$ -int; zeros at  $\pm 5$ . That leads to  $(0, -25)$ ,  $\pm 5$ .
21. Use the structure of the expression to find the important point, then check that it fits the context. A downward-opening parabola reaches its maximum at the vertex. The maximum value is 5. That leads to 5.
22. Because the parabola opens up, the vertex gives the minimum value. Its  $y$ -value is  $-3$ .
23. Use the given numbers to build the model, then finish the calculation.  $t = -\frac{48}{32} = 1.5$ .  $h(1.5) = -36 + 72 = 36$  ft.
24. For a table question, slow down and locate the exact row, column, or cell before calculating. Zeros:  $x^2 = 16 \Rightarrow x = \pm 4$ . Width = 8. Vertex:  $(0, 16)$ . Max height = 16. This gives width 8, height 16.
25. First identify the feature of the graph or equation that matches the wording of the question. Vertex:  $p = -\frac{40}{4} = 10$ .  $R(10) = -200 + 400 = 200$ . That leads to  $p = \$10$ ,  $R = \$200$ .
26.  $h = 0$ :  $-16t^2 + 8t + 24 = 0 \Rightarrow 2t^2 - t - 3 = 0 \Rightarrow (2t - 3)(t + 1) = 0$ . Positive:  $t = \frac{3}{2}$ .



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