

# Linear vs. Nonlinear Functions

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 24

## Q Quick Review

A **linear function** can be written in the form  $y = mx + b$ : the variable  $x$  appears only to the first power — no exponents, no  $x$  in a denominator, no square roots. Its graph is a straight line, and in a table it has a *constant rate of change* (the  $y$ -values jump by the same amount each time  $x$  steps up by 1). A **nonlinear function** breaks at least one of those rules — for example  $y = x^2$  or  $y = \frac{6}{x}$ . A quick check: if you see  $x^2$ ,  $x^3$ ,  $\sqrt{x}$ , or  $x$  in the bottom of a fraction, it is nonlinear.

◇ **Example:** Is  $y = x^2 + 3$  linear or nonlinear? What about  $y = 5x - 7$ ?  
 ⇒ Look at the powers of  $x$ . In  $y = x^2 + 3$ , the  $x$  is squared, so it is *not* in the form  $y = mx + b$  — that makes it nonlinear, and its graph is a curve. In  $y = 5x - 7$ , the  $x$  is only to the first power, with slope 5 and intercept  $-7$ , so it matches  $y = mx + b$  perfectly — it is linear.

**Answer:**  $x^2 + 3$ : nonlinear;  $5x - 7$ : linear

## PRACTICE

Decide whether each function is linear or nonlinear.

- |                           |       |                           |       |
|---------------------------|-------|---------------------------|-------|
| 1. $y = 2x + 5$           | _____ | 11. $y = 9x - 1$          | _____ |
| 2. $y = x^2$              | _____ | 12. $y = \frac{5}{x} + 2$ | _____ |
| 3. $y = -3x$              | _____ | 13. $y = -x + 6$          | _____ |
| 4. $y = \frac{8}{x}$      | _____ | 14. $y = 4x^2$            | _____ |
| 5. $y = x - 12$           | _____ | 15. $y = 10 - 3x$         | _____ |
| 6. $y = x^3 + 1$          | _____ | 16. $y = x^2 + x + 1$     | _____ |
| 7. $y = \frac{1}{2}x + 4$ | _____ | 17. $y = \frac{x}{3} - 2$ | _____ |
| 8. $y = \sqrt{x}$         | _____ | 18. $y = 2^x$             | _____ |
| 9. $y = 7$                | _____ | 19. $y = 6x + 0$          | _____ |
| 10. $y = 2x^2 - x$        | _____ | 20. $y = \sqrt{x} + 3x$   | _____ |

## ◆ Word Problems

21. A taxi charges \$3 plus \$2 per mile, so the cost is  $y = 2x + 3$ . Is the cost a linear or nonlinear function of the miles driven?  
 \_\_\_\_\_
22. The area of a square is  $A = s^2$ , where  $s$  is the side length. Is area a linear or nonlinear function of the side length? \_\_\_\_\_
23. A table shows a plant's height: week 0 → 4 cm, week 1 → 7 cm, week 2 → 10 cm, week 3 → 13 cm. Is the height a linear or nonlinear function of the week? \_\_\_\_\_
24. A table shows a bacteria count: hour 0 → 2, hour 1 → 4, hour 2 → 8, hour 3 → 16. Is the count a linear or nonlinear function of the hour? \_\_\_\_\_



## Answer Keys

- |               |               |
|---------------|---------------|
| 1. linear     | 13. linear    |
| 2. nonlinear  | 14. nonlinear |
| 3. linear     | 15. linear    |
| 4. nonlinear  | 16. nonlinear |
| 5. linear     | 17. linear    |
| 6. nonlinear  | 18. nonlinear |
| 7. linear     | 19. linear    |
| 8. nonlinear  | 20. nonlinear |
| 9. linear     | 21. linear    |
| 10. nonlinear | 22. nonlinear |
| 11. linear    | 23. linear    |
| 12. nonlinear | 24. nonlinear |

### Step-by-Step Explanations

- |  |   |
|--|---|
| <p>1. The <math>x</math> is to the first power and it fits <math>y = mx + b</math>, so it is linear.</p> <p>2. The <math>x</math> is squared, so the graph is a curve — nonlinear.</p> <p>3. This is <math>y = mx + b</math> with <math>m = -3</math> and <math>b = 0</math>, so it is linear.</p> <p>4. The <math>x</math> sits in the denominator, which breaks the linear form — nonlinear.</p> <p>5. The <math>x</math> is first power with slope 1 and intercept <math>-12</math> — linear.</p> <p>6. An <math>x^3</math> term means the graph is a curve — nonlinear.</p> <p>7. A fractional slope is fine; the <math>x</math> is still first power, so it is linear.</p> <p>8. A square root of <math>x</math> is not first power, so the function is nonlinear.</p> <p>9. A constant function is <math>y = 0 \cdot x + 7</math> — a horizontal line, which is linear.</p> <p>10. The <math>2x^2</math> term makes this nonlinear, even though it also has an <math>x</math> term.</p> <p>11. First-power <math>x</math> in the form <math>y = mx + b</math> — linear.</p> <p>12. With <math>x</math> in the denominator, the function is nonlinear.</p> <p>13. This is <math>y = mx + b</math> with <math>m = -1</math>, <math>b = 6</math> — linear.</p> <p>14. The <math>x</math> is squared, so the graph curves — nonlinear.</p> | <p>15. Rewritten as <math>y = -3x + 10</math>, the <math>x</math> is first power — linear.</p> <p>16. The <math>x^2</math> term breaks the linear form — nonlinear.</p> <p>17. Here <math>\frac{x}{3}</math> means <math>\frac{1}{3}x</math>, a first-power term — linear.</p> <p>18. The <math>x</math> is an <i>exponent</i>, not a base — that is exponential growth, which is nonlinear.</p> <p>19. This is just <math>y = 6x</math>, a first-power function — linear.</p> <p>20. The <math>\sqrt{x}</math> term is not first power, so even with the <math>3x</math> the function is nonlinear.</p> <p>21. The cost rises by the same \$2 for every extra mile — a constant rate of change. In the form <math>y = 2x + 3</math> the <math>x</math> is first power, so it is linear.</p> <p>22. The side length is squared, so doubling <math>s</math> does not double <math>A</math> — it quadruples it. A squared variable means the function is nonlinear.</p> <p>23. Each week the height goes up by exactly 3 cm — a constant rate of change. A constant rate means the function is linear.</p> <p>24. The count does not rise by a fixed amount — it <i>doubles</i> each hour (<math>+2, +4, +8</math>). A changing rate of change means the function is nonlinear.</p> |
|--|---|



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