

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

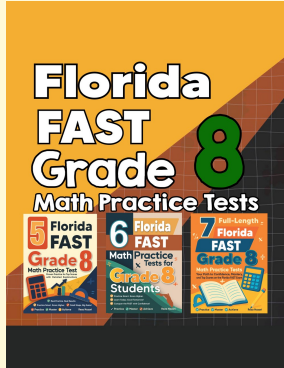
- | | |
|---------------|---------------|
| 1. linear | 13. linear |
| 2. nonlinear | 14. nonlinear |
| 3. linear | 15. linear |
| 4. nonlinear | 16. nonlinear |
| 5. linear | 17. linear |
| 6. nonlinear | 18. nonlinear |
| 7. linear | 19. linear |
| 8. nonlinear | 20. nonlinear |
| 9. linear | 21. linear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

Step-by-Step Explanations

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



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