Linear vs. Nonlinear Functions

Name: _____	Date: _____	Score: _____ / 24

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. $y = 2x + 5$ _____
2. $y = x^2$ _____
3. $y = -3x$ _____
4. $y = \frac{8}{x}$ _____
5. $y = x - 12$ _____
6. $y = x^3 + 1$ _____
7. $y = \frac{1}{2}x + 4$ _____
8. $y = \sqrt{x}$ _____
9. $y = 7$ _____
10. $y = 2x^2 - x$ _____
11. $y = 9x - 1$ _____
12. $y = \frac{5}{x} + 2$ _____
13. $y = -x + 6$ _____
14. $y = 4x^2$ _____
15. $y = 10 - 3x$ _____
16. $y = x^2 + x + 1$ _____
17. $y = \frac{x}{3} - 2$ _____
18. $y = 2^x$ _____
19. $y = 6x + 0$ _____
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 $0 \to 4$ cm, week $1 \to 7$ cm, week $2 \to 10$ cm, week $3 \to 13$ cm. Is the height a linear or nonlinear function of the week?
_____

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

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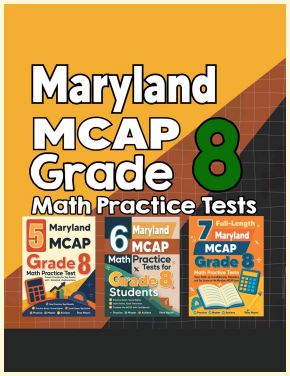

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