

# Inverse Functions

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

## Q Quick Review

The **inverse function**  $f^{-1}$  “undoes”  $f$ : if  $f(a) = b$ , then  $f^{-1}(b) = a$ . Algebraically, to find  $f^{-1}$ : **(1)** replace  $f(x)$  with  $y$ , **(2)** swap  $x$  and  $y$ , **(3)** solve for  $y$ . The result is  $f^{-1}(x)$ . To **verify** that two functions are inverses, check that  $f(f^{-1}(x)) = x$  and  $f^{-1}(f(x)) = x$ . **Graphically**,  $f^{-1}$  is the reflection of  $f$  across the line  $y = x$ . (Points swap:  $(a, b)$  on  $f$  becomes  $(b, a)$  on  $f^{-1}$ .) A function has an inverse *function* only if it’s one-to-one — linear functions with nonzero slope always do.

## PRACTICE

Find the inverse, verify, or solve.

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|---|--|
| 1. $f(x) = 3x + 2$ ; $f^{-1}$ _____                         | 11. $f(x) = 2x$ ; $f^{-1}$ _____                 |
| 2. $f(x) = \frac{x}{5} - 1$ ; $f^{-1}$ _____                | 12. $f(x) = x - 5$ ; $f^{-1}$ _____              |
| 3. $f(x) = 7x$ ; $f^{-1}$ _____                             | 13. $f(x) = 3x + 12$ ; $f^{-1}(15)$ _____        |
| 4. $f(x) = -2x + 9$ ; $f^{-1}$ _____                        | 14. $f(x) = -x$ ; $f^{-1}$ _____                 |
| 5. $f(x) = x + 10$ ; $f(x) = 25$ , $x = ?$ _____            | 15. $f(x) = x^3$ ; $f^{-1}$ _____                |
| 6. $f(x) = 5x - 3$ ; $f(x) = 22$ , $x = ?$ _____            | 16. $f(x) = \sqrt{x}$ ; $f^{-1}(x \geq 0)$ _____ |
| 7. $f(x) = \frac{x-4}{3}$ ; $f^{-1}$ _____                  | 17. $f(x) = 2x + 8$ ; $f^{-1}(0)$ _____          |
| 8. $f(x) = 8 - x$ ; $f^{-1}$ _____                          | 18. $f^{-1}$ of $(2, 7)$ on $f$ _____            |
| 9. $f(x) = 6x + 1$ ; <b>verify</b> $f(f^{-1}(x)) = x$ _____ | 19. $f(x) = \frac{x+1}{2}$ ; $f^{-1}$ _____      |
| 10. $f(x) = \frac{x}{2} + 7$ ; $f(x) = 10$ , $x = ?$ _____  | 20. $f(x) = 10x - 3$ ; $f^{-1}(7)$ _____         |

## ◆ VISUAL PRACTICE

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

21. The table shows  $f$ . Find  $f^{-1}(5)$ .

$x$	1	2	3
$f(x)$	3	5	9

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

22. The table shows  $f$ . Find  $f^{-1}(9)$ .

$x$	-1	0	4
$f(x)$	2	6	9

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

## ◆ Word Problems

23. The formula  $F = \frac{9}{5}C + 32$  converts Celsius to Fahrenheit. Find the inverse function, then use it to convert 212°F back to Celsius. \_\_\_\_\_

24. A taxi fare is modeled by  $f(d) = 2.50d + 3.00$ , where  $d$  is the number of miles traveled. If a rider paid \$15.50, use the inverse idea to find the distance traveled. \_\_\_\_\_

25. A coffee shop’s revenue function is  $R(p) = 20p - 100$  dollars when selling at price  $p$  per cup. What price yields \$500 revenue? \_\_\_\_\_

26. The function  $w(h) = 2.2h$  converts kilograms to pounds. Find the inverse and convert 176 lbs. \_\_\_\_\_



## Answer Keys

- |   |   |
|---|---|
| <p>1. <math>\frac{x-2}{3}</math></p> <p>2. <math>5(x+1)</math></p> <p>3. <math>\frac{x}{7}</math></p> <p>4. <math>\frac{9-x}{2}</math></p> <p>5. <math>x = 15</math></p> <p>6. <math>x = 5</math></p> <p>7. <math>3x + 4</math></p> <p>8. <math>8 - x</math></p> <p>9. yes</p> <p>10. <math>x = 6</math></p> <p>11. <math>\frac{x}{2}</math></p> <p>12. <math>x + 5</math></p> <p>13. 1</p> | <p>14. <math>-x</math></p> <p>15. <math>\sqrt[3]{x}</math></p> <p>16. <math>x^2</math></p> <p>17. <math>-4</math></p> <p>18. <math>(7, 2)</math></p> <p>19. <math>2x - 1</math></p> <p>20. 1</p> <p>21. 2</p> <p>22. 4</p> <p>23. <math>C = \frac{5}{9}(F - 32); 100^\circ\text{C}</math></p> <p>24. <math>d = 5</math></p> <p>25. <math>p = \\$30</math></p> <p>26. <math>h = 80 \text{ kg}</math></p> |
|---|---|

### Step-by-Step Tutor Notes

1. Read the table by matching the correct row and column first, then use the count or total that fits the question.  $y = 3x + 2 \Rightarrow x = 3y + 2 \Rightarrow y = \frac{x-2}{3}$ . This gives  $\frac{x-2}{3}$ .
2.  $y = \frac{x}{5} - 1 \Rightarrow x = \frac{y}{5} - 1 \Rightarrow x + 1 = \frac{y}{5} \Rightarrow y = 5(x + 1)$ .
3. This is a good place to slow down, check the notation, and simplify cleanly. Multiplication by 7 is undone by division by 7. So the answer is  $\frac{x}{7}$ .
4. For a table question, slow down and locate the exact row, column, or cell before calculating.  $y = -2x + 9 \Rightarrow x = -2y + 9 \Rightarrow 2y = 9 - x \Rightarrow y = \frac{9-x}{2}$ . This gives  $\frac{9-x}{2}$ .
5. Use the labels on the display first; they tell you which count or total belongs in the answer.  $x + 10 = 25 \Rightarrow x = 15$ . (Same as  $f^{-1}(25) = 15$ .) This gives  $x = 15$ .
6. Read the table by matching the correct row and column first, then use the count or total that fits the question.  $5x - 3 = 22 \Rightarrow 5x = 25 \Rightarrow x = 5$ . This gives  $x = 5$ .
7. Read the table by matching the correct row and column first, then use the count or total that fits the question.  $y = \frac{x-4}{3} \Rightarrow x = \frac{y-4}{3} \Rightarrow 3x = y - 4 \Rightarrow y = 3x + 4$ . This gives  $3x + 4$ .
8. Read the table by matching the correct row and column first, then use the count or total that fits the question.  $y = 8 - x \Rightarrow x = 8 - y \Rightarrow y = 8 - x$ . (Self-inverse!). This gives  $8 - x$ .
9.  $f^{-1}(x) = \frac{x-1}{6}$ . Then  $f(f^{-1}(x)) = 6 \cdot \frac{x-1}{6} + 1 = x - 1 + 1 = x$ . ✓
10. Use the labels on the display first; they tell you which count or total belongs in the answer.  $\frac{x}{2} + 7 = 10 \Rightarrow \frac{x}{2} = 3 \Rightarrow x = 6$ . This gives  $x = 6$ .
11. This is a good place to slow down, check the notation, and simplify cleanly. Doubling is undone by halving. So the answer is  $\frac{x}{2}$ .
12. Move carefully through the arithmetic; one clean operation usually unlocks the next one. Subtracting 5 is undone by adding 5. After simplifying, the answer is  $x + 5$ .
13. Read the table by matching the correct row and column first, then use the count or total that fits the question. Solve  $f(x) = 15: 3x + 12 = 15 \Rightarrow x = 1$ . So  $f^{-1}(15) = 1$ . This gives 1.
14. Use the clue in the question first, then let the arithmetic finish the job. Negating is self-inverse:  $-(-x) = x$ . So the answer is  $-x$ .
15. Start with the definition the problem is testing, then apply it directly. Cubing is undone by taking cube root. So the answer is  $\sqrt[3]{x}$ .
16. Focus on the main idea of the problem, then simplify carefully. Square root is undone by squaring (with the domain restriction  $x \geq 0$  for both functions). So the answer is  $x^2$ .
17. Focus on the main idea of the problem, then simplify carefully. Solve  $2x + 8 = 0: x = -4$ . So the answer is  $-4$ .
18. Start with the definition the problem is testing, then apply it directly. Inverse swaps coordinates:  $(2, 7) \rightarrow (7, 2)$ . So the answer is  $(7, 2)$ .
19. Use the labels on the display first; they tell you which count or total belongs in the answer.  $y = \frac{x+1}{2} \Rightarrow x = \frac{y+1}{2} \Rightarrow 2x = y + 1 \Rightarrow y = 2x - 1$ . This gives  $2x - 1$ .
20. Use the labels on the display first; they tell you which count or total belongs in the answer. Solve  $10x - 3 = 7: 10x = 10 \Rightarrow x = 1$ . This gives 1.
21.  $f^{-1}(5)$  asks which input gives output 5. The table shows that input is 2.
22. Use the clue in the question first, then let the arithmetic finish the job.  $f^{-1}(9)$  asks which input gives output 9. That input is 4. So the answer is 4.
23. Solve for  $C$ : subtract 32, then multiply by  $\frac{5}{9}$ :  $C = \frac{5}{9}(F - 32)$ . At  $F = 212$ :  $\frac{5}{9}(180) = 100^\circ\text{C}$ . (Water's boiling point in both scales.)
24. Solve  $2.50d + 3.00 = 15.50: 2.50d = 12.50$ , so  $d = 5$  miles. (Or compute  $f^{-1}(15.50)$ .)
25. For a table question, slow down and locate the exact row, column, or cell before calculating.  $20p - 100 = 500 \Rightarrow 20p = 600 \Rightarrow p = 30$  dollars per cup. This gives  $p = \$30$ .
26. Name the quantities first so the model is easy to read. Inverse:  $h = \frac{w}{2.2}$ . At  $w = 176: h = \frac{176}{2.2} = 80 \text{ kg}$ .



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