

Inverse Functions

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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.

- | | |
|---|--|
| 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. $f(x) = 6x + 1$; verify $f(f^{-1}(x)) = x$ _____ | 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. _____



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Answer Keys

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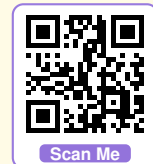
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