

# Constant of Proportionality ( $k$ )

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_\_ / 18

Every proportional relationship has a magic number hiding inside it: the **constant of proportionality**,  $k$ . It tells you how many units of  $y$  you get for each 1 unit of  $x$ , so  $k = \frac{y}{x}$ . Once you know  $k$ , you can write the equation  $y = kx$  and predict *any* value in the relationship—that is real mathematical power! The best part is that  $k$  always has a concrete meaning, like dollars per item or miles per gallon, so it connects the math to the real world.

## Key Concepts & Quick Review

**From a table:**  $k = \frac{y}{x}$  (same for every row). **From an equation:**  $y = kx \Rightarrow k$  is the coefficient of  $x$ .

**Given  $k$ , find  $y$ :** multiply  $k \times x$ . **Given  $k$ , find  $x$ :** divide  $y \div k$ . Larger  $k$  means a steeper graph.

$x$	$y$
2	6
4	12

$y \div x \rightarrow$   $k = 6 \div 2 = 3$   
 $y = 3x$

$k$  tells how much  $y$  there is for each 1 unit of  $x$ .

## Examples

① A table shows: (2, 7), (4, 14), (6, 21), (8, 28). Find  $k$  and write the equation.

**Think It Through:** To find the constant of proportionality, divide  $y$  by  $x$  in the table. Each pair gives the same value:  $\frac{7}{2} = 3.5$ ,  $\frac{14}{4} = 3.5$ ,  $\frac{21}{6} = 3.5$ , and  $\frac{28}{8} = 3.5$ . Since the ratio is always 3.5, that is the constant  $k$ . A proportional relationship with constant  $k$  is written as  $y = kx$ , so the equation is  $y = 3.5x$ .

**Answer:**  $k = 3.5$ ;  $y = 3.5x$

② A car's fuel economy is proportional: it uses 2.5 gal for every 50 mi driven. Find  $k$  (miles per gallon), write the equation for total miles  $y$  given gallons  $x$ , and find how far the car travels on 11 gal.

**Think It Through:** The constant of proportionality here is miles per gallon, so divide miles by gallons:  $\frac{50}{2.5} = 20$ . That means the car travels 20 mi for each gallon of gas. Using  $y = kx$ , the equation becomes  $y = 20x$ , where  $x$  is gallons and  $y$  is miles. For 11 gal, substitute  $x = 11$  and get  $y = 20 \times 11 = 220$  miles. The units help you decide which quantity goes on top when finding  $k$ .

**Answer:**  $k = 20$  mpg; 220 mi on 11 gal

## Practice Problems

Find the constant of proportionality  $k$ , or use the given  $k$  to find the missing value.



1. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $y = 12$  and  $x = 3$  to find  $k$ .
2. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $y = 35$  and  $x = 5$  to find  $k$ .
3. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $y = 48$  and  $x = 8$  to find  $k$ .
4. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $y = 2.4$  and  $x = 4$  to find  $k$ .
5. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $y = \frac{3}{2}$  and  $x = 3$  to find  $k$ .
6. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $y = 9$  and  $x = 6$  to find  $k$ .
7. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $k = 4$  and  $x = 7$  to find  $y$ .
8. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $k = 2.5$  and  $x = 6$  to find  $y$ .
9. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $k = \frac{1}{3}$  and  $x = 9$  to find  $y$ .
10. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $k = 5$  and  $y = 40$  to find  $x$ .
11. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $k = 0.6$  and  $y = 4.8$  to find  $x$ .
12. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $k = \frac{3}{4}$  and  $y = 9$  to find  $x$ .
13. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $y = 7.2$  and  $x = 9$  to find  $k$ .
14. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $y = 100$  and  $x = 25$  to find  $k$ .
15. In the proportional relationship  $y = kx$ , \_\_\_\_\_ use  $k = 1.5$  and  $x = 10$  to find  $y$ .

### Study Tips

-   $k$  is always  $\frac{y}{x}$  — **dependent over independent**. Put the output quantity on top.
-  On a graph,  $k$  is the **slope** of the line through the origin. A steeper line means a larger  $k$ .
-  The unit of  $k$  tells you the **real-world rate**: if  $x$  is hours and  $y$  is miles, then  $k$  is miles per hour.

### Word Problems

16. A baker uses  $\frac{3}{2}$  cups of sugar for every 2 dozen cookies baked. Find  $k$  (cups per dozen), write the equation, and determine how many cups of sugar are needed to bake 10 dozen cookies. \_\_\_\_\_
17. Two painters work at proportional rates. Painter A completes  $\frac{3}{4}$  of a room per hour. Painter B completes 45 square feet per hour, and each room is 90 sq ft. Find  $k$  for each painter in rooms per hour and determine who paints faster. \_\_\_\_\_
18. This graph shows distance versus time for a runner. Read the marked lattice point off the graph, find the constant of proportionality  $k$  (the runner's speed), state the equation  $y = kx$ , and use it to predict the distance after 7 hours.





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## Answer Keys

- |   |   |
|---|---|
| <p>1) 4</p> <p>2) 7</p> <p>3) 6</p> <p>4) 0.6</p> <p>5) <math>\frac{1}{2}</math></p> <p>6) 1.5</p> <p>7) 28</p> <p>8) 15</p> <p>9) 3</p> <p>10) 8</p> | <p>11) 8</p> <p>12) 12</p> <p>13) 0.8</p> <p>14) 4</p> <p>15) 15</p> <p>16) <math>k = \frac{3}{4}</math> cup/dozen; <math>y = \frac{3}{4}x</math>; 7.5 cups</p> <p>17) Painter A: 0.75 room/hr; Painter B: 0.5 room/hr; Painter A</p> <p>18) Point (2, 5); <math>k = 2.5</math> mph; <math>y = 2.5x</math>; 17.5 mi</p> |
|---|---|

### Step-by-Step Explanations

**Strategy:** For Solving Real-World Problems with Rational Numbers, sort the quantities by what they mean before choosing operations. A labeled setup helps students see which numbers are being combined and why.

**Practice 1:**  $\frac{3}{4} \times (-8) + \frac{1}{2} =$  **Answer:**  $-\frac{11}{2}$

For the first worked item, choose the rule named by the topic, substitute carefully, and simplify one line at a time.

**Practice 15:**  $-1\frac{2}{3} \div \frac{5}{9} + (-0.2) =$  **Answer:**  $-\frac{16}{5}$

Near the end of this topic, choose the rule named by the topic, substitute carefully, and simplify one line at a time.

**Word-problem notes:**

**16. Answer:** Week 2 loss:  $-\$168.20$ ; week 3:  $\$630.75$ ; total:  $\$883.05$ ; overall profit.

Week 1 is a profit of  $\$420.50$ . Week 2 is a loss equal to  $\frac{2}{5}$  of that, so compute  $420.50 \times \frac{2}{5} = 168.20$  and record it as  $-\$168.20$ . Week 3 is  $1\frac{1}{2} = \frac{3}{2}$  times week 1, so  $420.50 \times \frac{3}{2} = 630.75$ . Now combine the three weeks:  $420.50 - 168.20 + 630.75 = 883.05$ . Because the total is positive, the business made an overall profit of  $\$883.05$ . The signs tell the story of profit versus loss.

**17. Answer:** 8 intervals; change =  $8 \times (-\frac{3}{8}) = -3^\circ\text{C}$ ; final =  $-6.5^\circ\text{C}$ ; yes, still above  $-8^\circ\text{C}$ .

First count how many quarter-minute intervals fit into 2 min:  $2 \div \frac{1}{4} = 8$ . Each interval changes the temperature by  $-\frac{3}{8}^\circ\text{C}$ , so the total change is  $8 \times (-\frac{3}{8}) = -3^\circ\text{C}$ . Add that change to the starting temperature:  $-3.5 + (-3) = -6.5^\circ\text{C}$ . Finally, compare  $-6.5^\circ\text{C}$  to the lower limit of  $-8^\circ\text{C}$ . Since  $-6.5 > -8$ , the reaction is still within bounds. This last comparison step matters just as much as the arithmetic.



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