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

$\xrightarrow{y \div x}$ $k = 6 \div 2 = 3$, $y = 3x$

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

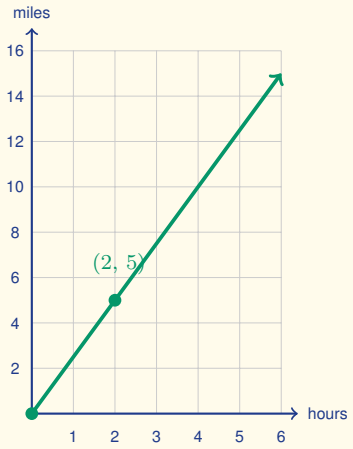
- k is always $\frac{y}{x}$ — **dependent over independent**. Put the output quantity on top.
- On a graph, k is the **slope** of the line through the origin. A steeper line means a larger k.
- The unit of k tells you the **real-world rate**: if x is hours and y is miles, then k is miles per hour.

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.


miles
16
14
12
10
8
6
4
2
(2, 5)
hours
1
2
3
4
5
6

Answer Keys

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

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 $= 8 \times (-\frac{3}{8}) = -3°$C; final $= -6.5°$C; yes, still above $-8°$C.
First count how many quarter-minute intervals fit into $2\ min$: $2 \div \frac{1}{4} = 8$. Each interval changes the temperature by $-\frac{3}{8}°$C, so the total change is $8 \times \left(-\frac{3}{8}\right) = -3°$C. Add that change to the starting temperature: $-3.5 + (-3) = -6.5°$C. Finally, compare $-6.5°$C to the lower limit of $-8°$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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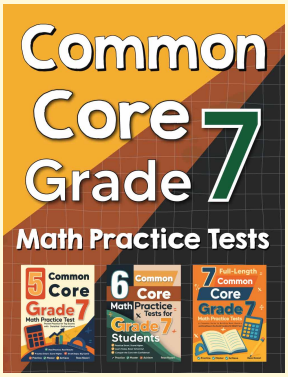

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