

# Proportional vs. Non-Proportional Relationships

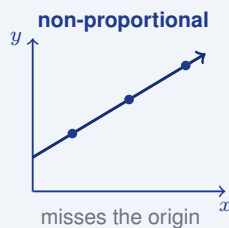
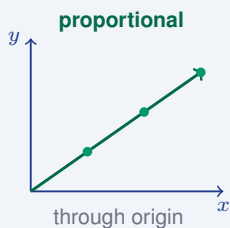
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Not all relationships play by the same rules, and this topic teaches you how to tell them apart! In a **proportional relationship**, the ratio  $\frac{y}{x}$  stays the same for every pair, the table passes through  $(0, 0)$ , and the graph is a straight line through the origin. In a **non-proportional relationship**, there is usually an extra starting amount or the ratios keep changing. Once you can spot the difference, you will always know which equation or graph to reach for.

## Key Concepts & Quick Review

**Proportional:**  $\frac{y}{x}$  is the same for every pair  $(x, y)$  in the table; graph passes through  $(0, 0)$ . **Non-proportional:** ratios differ, or  $y \neq 0$  when  $x = 0$ .

**Quick test:** compute  $\frac{y}{x}$  for each row. If all values match, the relationship is proportional. If even one differs, it is non-proportional.



### Examples

① Determine if the table is proportional or non-proportional:

$x$	$y$
1	4
2	8
3	12
4	16

**Think It Through:** Check whether the ratio  $\frac{y}{x}$  stays the same in every row. Here,  $\frac{4}{1} = 4$ ,  $\frac{8}{2} = 4$ ,  $\frac{12}{3} = 4$ , and  $\frac{16}{4} = 4$ . Since the ratio is constant, the relationship is proportional. The constant of proportionality is  $k = 4$ , which means  $y$  is always 4 times  $x$ .

**Answer:** Proportional;  $k = 4$

② A plumber charges a \$40 flat fee plus \$30 per hour. Make a table for 1–4 hours and determine if the relationship is proportional.

**Think It Through:** The cost rule is  $y = 30x + 40$  because there is a \$40 starting fee and then \$30 for each hour. That gives the table  $(1, 70)$ ,  $(2, 100)$ ,  $(3, 130)$ , and  $(4, 160)$ . If you divide  $y$  by  $x$  in each row, the ratios are not the same, so the relationship is not proportional. Another quick check is the origin test: when  $x = 0$ , the cost would still be 40, not 0, so the graph does not pass through  $(0, 0)$ .



**Answer:** *Non-proportional (flat fee shifts the ratio)*

**Practice Problems**

Check whether each table shows a proportional relationship. Record P for proportional or NP for non-proportional.

1.  $\begin{array}{l|l} x & 2 & 4 & 6 \\ y & 6 & 12 & 18 \end{array}$  \_\_\_\_\_

2.  $\begin{array}{l|l} x & 1 & 3 & 5 \\ y & 4 & 10 & 16 \end{array}$  \_\_\_\_\_

3.  $\begin{array}{l|l} x & 2 & 5 & 8 \\ y & 10 & 25 & 40 \end{array}$  \_\_\_\_\_

4.  $\begin{array}{l|l} x & 3 & 6 & 9 \\ y & 12 & 24 & 36 \end{array}$  \_\_\_\_\_

5.  $\begin{array}{l|l} x & 1 & 2 & 4 \\ y & 5 & 9 & 17 \end{array}$  \_\_\_\_\_

6.  $\begin{array}{l|l} x & 4 & 8 & 12 \\ y & 3 & 6 & 9 \end{array}$  \_\_\_\_\_

7.  $\begin{array}{l|l} x & 2 & 3 & 5 \\ y & 7 & 10 & 16 \end{array}$  \_\_\_\_\_

8.  $\begin{array}{l|l} x & 5 & 10 & 15 \\ y & 8 & 16 & 24 \end{array}$  \_\_\_\_\_

9.  $\begin{array}{l|l} x & 1 & 4 & 7 \\ y & 0 & 12 & 21 \end{array}$  \_\_\_\_\_

10.  $\begin{array}{l|l} x & 6 & 9 & 12 \\ y & 2 & 3 & 4 \end{array}$  \_\_\_\_\_

**Study Tips**

-  The fastest check: does the table include the point (0, 0)? A proportional relationship **must** pass through the origin.
-  A **flat fee, starting balance, or one-time charge** is a dead giveaway for a non-proportional relationship.
-  In a proportional table, every  $y$  value equals  $k \times x$  for the same constant  $k$  — you only need to find  $k$  once.

**Word Problems**

11. Two cell-phone plans are available. Plan A costs \$0.10 per text message. Plan B costs \$5.00 per month plus \$0.05 per text. Create a  $y/x$  table for 10, 20, 30, and 40 texts under each plan. Which plan is proportional?  
\_\_\_\_\_
12. A swimming pool is filled at a constant rate of 200 gal per hour starting from empty. A second pool already has 500 gal and is filled at 150 gal/hr. Write an equation for each pool’s volume after  $x$  hours. Which relationship is proportional? \_\_\_\_\_
13. Two relationships are graphed here. Decide which graph (**Graph A** or **Graph B**) shows a proportional relationship, and justify your choice using *both* criteria for proportionality (passes through the origin AND is a straight line). For the proportional graph, give the constant of proportionality.





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## Answer Keys

- |  |   |
|--|---|
| <p>1) P</p> <p>2) NP</p> <p>3) P</p> <p>4) P</p> <p>5) NP</p> <p>6) P</p> <p>7) NP</p> <p>8) P</p> | <p>9) NP</p> <p>10) P</p> <p>11) Plan A is proportional (<math>y/x = 0.10</math> always); Plan B is non-proportional (flat fee).</p> <p>12) Pool 1 proportional; Pool 2 non-proportional</p> <p>13) Graph A is proportional (line through origin); <math>k = 2</math>. Graph B is not (does not pass through the origin).</p> |
|--|---|

### Step-by-Step Explanations

**Strategy:** For Dividing Integers and Rational Numbers, divide by the rational number using reciprocals when needed, then finish with the correct sign. A quotient in context should say whether it is a rate, a time, a distance, or a signed change.

**Practice 1:**  $(-6) \div \frac{3}{4} =$  **Answer:** -8

For the first sample, rewrite division by  $\frac{3}{4}$  as multiplication by  $\frac{4}{3}$ , then keep the quotient negative.

**Practice 15:**  $5\frac{1}{2} \div (-2\frac{3}{4}) =$  **Answer:** -2

Late in the set, convert both mixed numbers to improper fractions; the signs differ, so the simplified quotient is negative.

**Word-problem notes:**

**16. Answer:** Rate:  $-10\frac{1}{2} \div 3\frac{1}{2} = -3$  °F/hr; final temp:  $-5 + (-10.5) = -15.5$ °F.

Convert the mixed numbers first:  $-10\frac{1}{2} = -\frac{21}{2}$  and  $3\frac{1}{2} = \frac{7}{2}$ . To find the hourly rate, divide total change by total time:  $(-\frac{21}{2}) \div (\frac{7}{2})$ . Use Keep, Change, Flip:  $(-\frac{21}{2}) \times (\frac{2}{7}) = -3$ . So the freezer changes by  $-3$ °F per hour. Starting at  $-5$ °F and dropping another  $10.5$ °F gives  $-5 + (-10.5) = -15.5$ °F. The negative rate tells us the freezer is getting colder over time.

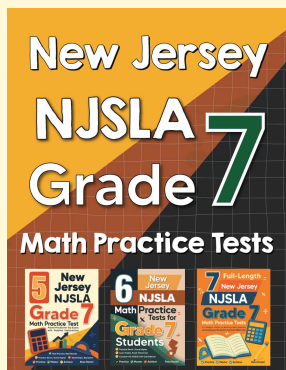
**17. Answer:** Drain alone: 12 min; combined rate:  $-\frac{13}{30}$  gal/min; combined time:  $\approx 23.1$  min.

If the pipe drains  $\frac{5}{6}$  gal each minute, then the time to drain 10 gal is  $10 \div \frac{5}{6} = 10 \times \frac{6}{5} = 12$  min. Now include the second pipe. The drain rate is  $-\frac{5}{6}$  gal per minute and the fill rate is  $+\frac{2}{5}$  gal per minute. Add them to get the combined rate:  $-\frac{5}{6} + \frac{2}{5} = -\frac{25}{30} + \frac{12}{30} = -\frac{13}{30}$  gal per minute. The negative sign means the tank is still losing water overall. To find the time to drain 10 gal at that net rate, divide the amount by the rate's magnitude:  $10 \div \frac{13}{30} = \frac{300}{13} \approx 23.1$  min.



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