One-step equations

When exactly one thing has been done to a number, such as adding 18 or multiplying by 4, how do you undo it and find the number?

WORDS TO KNOW

One-step equation: an equation where one thing was done to the letter, so one move gets it alone.

Coefficient: the number that multiplies the letter. In $4x$ it is 4.

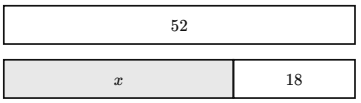
Check: put the answer back into the equation you started with.

Inverse operation: the operation that undoes another. Subtracting undoes adding. Dividing undoes multiplying.

Reciprocal: a fraction turned upside down. The reciprocal of $\frac{3}{4}$ is $\frac{4}{3}$, and the two multiply to 1.

KEY IDEAS

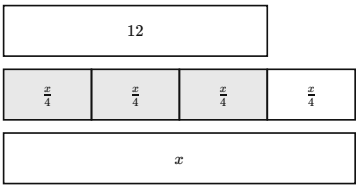
1. Undo an addition or a subtraction



In $x + 18 = 52$, the whole 52 is made of x and 18. Take the 18 off: subtract 18 from both sides, and $x = 34$.

> $x + p = q$ has the solution $x = q - p$.
>
> $x - p = q$ has the solution $x = q + p$.
>
> If the letter is the amount taken away, as in $p - x = q$, add x to both sides first. Then $x = p - q$.

2. Undo a multiplication or a division



To undo multiplying by the coefficient, divide both sides by it. To undo dividing, multiply. With a fraction coefficient, multiply both sides by its reciprocal. In the picture, three quarters of x is 12. One quarter is 4, so $x = 16$.

> $px = q$ has the solution $x = \frac{q}{p}$, as long as $p \neq 0$.
>
> Multiply both sides by the reciprocal of the coefficient. It is the same as dividing by the coefficient.

3. Write the equation from the story

Name the unknown with its unit. Find the sentence that says two amounts are equal. Solve, then check the answer in the words of the story and ask if it makes sense.

WATCH OUT

- **The word does not tell you the move.** "Sima swam 14 more lengths than Tamar, and Sima swam 40" gives $t + 14 = 40$, and you solve it by subtracting.
- **Do not do the same operation again.** In $x - 2 = 9$, subtracting 2 takes it away twice. Add 2 instead.
- **Multiply by the reciprocal, not the fraction itself.** Multiplying $\frac{2}{5}x$ by $\frac{2}{5}$ does not leave x alone.
- **The solution may not fit the story.** A number of plates or people must be a whole number. If it is not, say so. Do not round.

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WORKED EXAMPLES

Example 1. Solve (a) $x + 26 = 73$ and (b) $80 - w = 52.5$.

1. (a) 26 was added to x, so subtract 26 from both sides: $x = 73 - 26 = 47$.
2. (b) Here w is the amount taken away. Add w to both sides: $80 = 52.5 + w$.
3. Now subtract 52.5 from both sides: $w = 80 - 52.5 = 27.5$.

Answer: (a) $x = 47$ (b) $w = 27.5$. **Check:** 47 + 26 = 73 and 80 − 27.5 = 52.5.

Example 2. Solve (a) $8p = 26$ and (b) $\frac{3}{7}y = 24$.

1. (a) p was multiplied by 8, so divide both sides by 8: $p = 26 \div 8 = 3.25$.
2. (b) Multiply both sides by the reciprocal of $\frac{3}{7}$, which is $\frac{7}{3}$.

$$y = \frac{7}{3} \times 24 = \frac{168}{3} = 56$$

Answer: (a) $p = 3.25$ (b) $y = 56$. **Check:** 8 × 3.25 = 26, and $\frac{3}{7} \times 56 = \frac{168}{7} = 24$.

Example 3. Mia read 34 more pages than Jo. Mia read 96 pages. How many pages did Jo read?

1. Let j be the number of pages Jo read. Mia read 34 more, so $j + 34 = 96$.
2. The word is "more", but 34 was added to j. Subtract 34 from both sides: $j = 96 - 34 = 62$.

Answer: Jo read 62 pages. **Check in the story:** 62 pages and 34 more make 96, and a number of pages is a whole number.

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