

Solving Two-Step Equations: math lesson, Grade 7 – download the PDF

A one-step equation needs a single move to find the unknown. Many real situations hide two operations at once: a fee plus a price per item, a starting amount plus a weekly saving, a temperature conversion. In this chapter you will learn a reliable routine for undoing both operations, writing equations from word problems, and proving that your answer is right.

1. What is a two-step equation?

An equation says that two expressions have the same value. In a **two-step equation** the variable has been changed by **two operations**, so you need two inverse moves to free it. You will meet two main shapes:

- $px + q = r$, for example $3x + 4 = 19$: the variable is multiplied, and then a number is added or subtracted;
- $p(x + q) = r$, for example $4(x + 3) = 44$: a number is added to the variable first, and then the whole sum is multiplied.

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Definition: solution

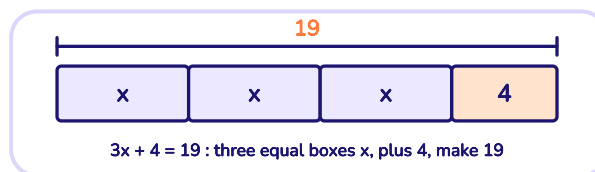
A **solution** of an equation is a value of the variable that makes the equation true. To **solve** an equation means to find all its solutions. Each two-step equation in this chapter has exactly one.

2. Inverse operations and the balance idea

Think of an equation as a balanced scale. Whatever you do to one side, you must do to the other, or the balance tips. Each operation has an **inverse operation** that undoes it.

Operation done to the variable	Inverse operation that undoes it
Add a number, $x + 7$	Subtract that number
Subtract a number, $x - 7$	Add that number
Multiply by a number, $7x$	Divide by that number
Divide by a number, $\frac{x}{7}$	Multiply by that number

Look at the bar model for $3x + 4 = 19$. Three equal boxes of size x and one box of 4 together make 19.



Take away the box of 4 from the total: three boxes of x make $19 - 4 = 15$. Share 15 into 3 equal boxes: each x is 5.

3. Solving $px + q = r$

P Property: equal operations

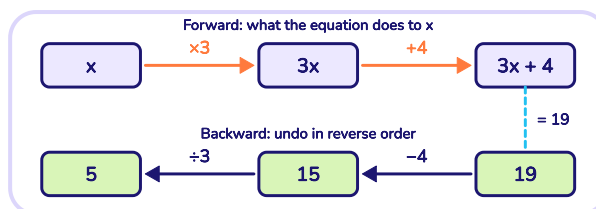
Adding, subtracting, multiplying or dividing **both sides** of an equation by the same number (never zero for multiplying or dividing) gives an equation with the same solution. This is why inverse operations are allowed.

M**Method: solve $px + q = r$**

1. Undo the addition or subtraction first: subtract q from both sides (or add it if q is negative).
2. You now have $px = r - q$. Divide both sides by p .
3. Write the answer as $x = \dots$
4. Check by replacing x in the original equation.

E**Example 1** Solve $3x + 4 = 19$.Subtract 4 from both sides: $3x = 15$.Divide both sides by 3: $x = 5$.Check: $3(5) + 4 = 15 + 4 = 19$. It works.**E****Example 2** Solve $5x - 9 = 26$.Add 9 to both sides: $5x = 35$.Divide by 5: $x = 7$.Check: $5(7) - 9 = 35 - 9 = 26$. It works.**A****Common mistake** Do not divide only one term. If you divide the equation $3x + 6 = 21$ by 3 right away, you must divide every term: $x + 2 = 7$. Subtracting first is usually easier and safer.**4. Working backward with a flow chart**

A flow chart shows what the equation does to x , step by step. To solve, run the chart backward: start from the result, and apply the inverse operations in **reverse order**.



Forward, x is multiplied by 3 and then increased by 4. Backward, 19 is decreased by 4 and then divided by 3. The two routes always meet in the same answer.

! Zyro's tip On my home planet we get dressed in order and undress in the opposite order. Equations work the same way: the last operation done to x is the first one you undo!

5. Solving $p(x + q) = r$

When a sum or difference sits inside parentheses and is multiplied, you have two valid routes.

M Method: solve $p(x + q) = r$

1. **Route A (divide first):** divide both sides by p , then subtract q .
2. **Route B (distribute first):** expand to $px + pq = r$, then solve like $px + q = r$.
3. Check in the original equation.

E Example 3 Solve $6(x - 2) = 42$.

Route A: divide by 6: $x - 2 = 7$. Add 2: $x = 9$.

Route B: $6x - 12 = 42$, so $6x = 54$ and $x = 9$.

Check: $6(9 - 2) = 6 \times 7 = 42$. Both routes agree.

Route A is faster when p divides r evenly. If it does not, as in $4(x + 1) = 10$, the answer is a fraction or decimal: $x + 1 = 2.5$, so $x = 1.5$.

6. Rational coefficients

The numbers p , q and r may be fractions, decimals or negative numbers. The routine does not change.

- **Divided by a number:** to undo $\frac{x}{4}$, multiply by 4.
- **Fraction coefficient:** to undo $\frac{2}{5}x$, multiply by the reciprocal $\frac{5}{2}$.
- **Decimal coefficient:** divide by the decimal, for example $2.5x = 10$ gives $x = 4$.
- **Negative coefficient:** divide by the negative number, and watch the sign: $-3x = -18$ gives $x = 6$.

E **Example 4** Solve $\frac{x}{4} - 3 = 2$.

Add 3: $\frac{x}{4} = 5$. Multiply by 4: $x = 20$.

Check: $\frac{20}{4} - 3 = 5 - 3 = 2$.

E **Example 5** Solve $\frac{2}{5}x + 1 = 7$.

Subtract 1: $\frac{2}{5}x = 6$. Multiply by $\frac{5}{2}$: $x = 6 \times \frac{5}{2} = 15$.

Check: $\frac{2}{5}(15) + 1 = 6 + 1 = 7$.

7. Writing equations from word problems

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Method: from words to an equation

1. Read the problem and say what the unknown is. Write “Let m = number of months”.
2. Find the fixed amount (paid once or at the start) and the amount that repeats.
3. Write the expression: repeating amount times the variable, plus or minus the fixed amount.
4. Set it equal to the total given, solve, and answer with a full sentence and units.

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Example 6 A video app charges \$5 to join and \$8 per month. Kai has paid \$61 in total. How many months has he subscribed?

Let m be the number of months: $8m + 5 = 61$.

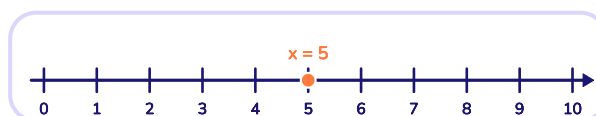
Subtract 5: $8m = 56$. Divide by 8: $m = 7$.

Kai has subscribed for 7 months. Check: $8(7) + 5 = 61$.

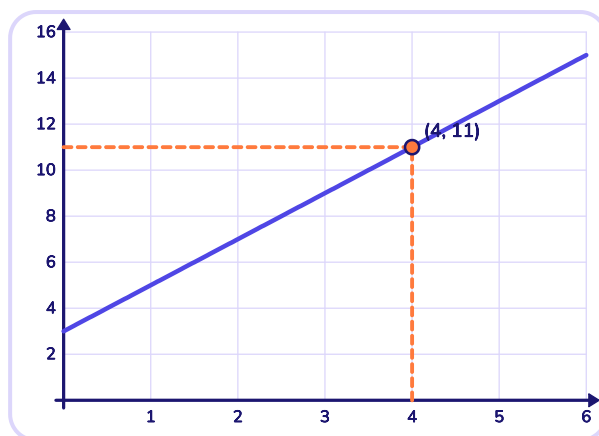
Watch the key phrases: “more than” and “plus” point to addition, “per” points to multiplication, and “twice” means times 2. “7 more than twice a number is 25” becomes $2n + 7 = 25$, not $2(n + 7) = 25$.

8. Checking and comparing methods

Always **check** a solution by substituting it into the *original* equation and confirming that both sides are equal. On a number line the solution is a single point, here $x = 5$:



You can also see a solution on a graph. The line $y = 2x + 3$ reaches the height 11 exactly when $x = 4$, so $2x + 3 = 11$ has the solution $x = 4$:



An **arithmetic solution** works backward with numbers only. An **algebraic solution** writes an equation and uses inverse operations. For “I think of a number, double it and add 5. I get 21”, the arithmetic way is $21 - 5 = 16$, then $16 \div 2 = 8$. The algebraic way is $2x + 5 = 21$, $2x = 16$, $x = 8$. The steps are identical; algebra simply gives them a clear written form that also works for harder problems.

Key takeaways

- A two-step equation has two operations on the variable, so it needs two inverse operations.
- Undo in reverse order: first add or subtract, then multiply or divide.
- For $px + q = r$: $x = \frac{r - q}{p}$. For $p(x + q) = r$: divide by p first, or distribute first.
- Do the same thing to both sides to keep the equation balanced.
- Fractions, decimals and negative numbers follow the same routine; use the reciprocal for a fraction.
- For word problems, define the variable, build the equation, solve, then answer in a sentence with units.
- Always check by substituting in the original equation.



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