

# Equations and Inequalities: math lesson, Grade 6 – download the PDF

A puzzle with a missing number, a scale that must stay balanced, a speed limit you cannot go over: all of these are about equations and inequalities. In this chapter you will learn to use a letter for an unknown number, to find the value that makes an equation true, to turn a story into an equation, and to describe a whole group of numbers with an inequality.

## 1. Variables as unknowns

A **variable** is a letter (such as  $x$ ,  $n$  or  $p$ ) that stands for a number. Sometimes the number is *unknown*: you are trying to find it. Sometimes the variable can take many different values. In this chapter we mostly use a variable as an unknown.

In algebra we do not write the multiplication sign next to a letter:  $5n$  means  $5 \times n$ , and  $\frac{n}{4}$  means  $n \div 4$ .

### D

#### Definition: expression and equation

An **expression** such as  $x + 7$  or  $3n$  is a calculation that contains a variable. An **equation** is a statement with an equal sign, such as  $x + 7 = 12$ . It says that two expressions have the same value.

## 2. Solutions of equations

A **solution** of an equation is a value of the variable that makes the equation true. To test a value, substitute it for the letter and compute both sides.

### E Example 1: testing a value

Is  $x = 8$  a solution of  $x + 14 = 22$ ? Substitute:  $8 + 14 = 22$ . Both sides are equal, so **yes**, 8 is a solution.

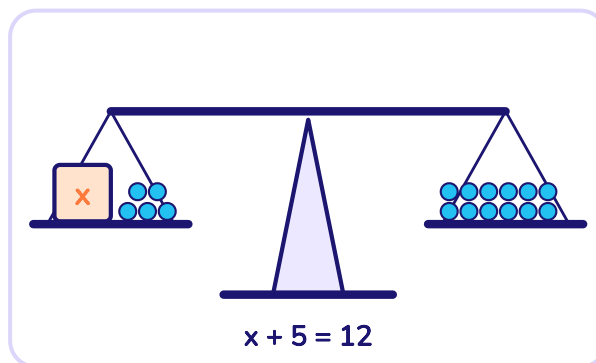
Is  $n = 5$  a solution of  $4n = 24$ ? Substitute:  $4 \times 5 = 20$ , and  $20 \neq 24$ . So **no**, 5 is not a solution.

### ⚠ Watch out

The equal sign does not mean “here comes the answer”. It means that the left side and the right side have the same value.

## 3. One-step equations: adding and subtracting

Think of an equation as a balance scale. If the two pans hold the same weight, the scale is level. To keep it level, whatever you do to one pan you must do to the other.



On the scale, remove 5 units from each pan. The box  $x$  is left alone on one side, and 7 units remain on the other:  $x = 7$ .

**M**

### Method: solve a one-step equation

1. Find the operation that is applied to the variable.
2. Do the **inverse operation** on *both* sides: subtraction undoes addition, addition undoes subtraction, division undoes multiplication, multiplication undoes division.
3. Write the solution, then check it by substituting.

**E**

### Example 2: addition and subtraction

Solve  $x + 14 = 33$ . Subtract 14 from both sides:  $x + 14 - 14 = 33 - 14$ , so  $x = 19$ .  
Check:  $19 + 14 = 33$ . Correct.

Solve  $y - 6 = 11$ . Add 6 to both sides:  $y = 11 + 6 = 17$ . Check:  $17 - 6 = 11$ .  
Correct.

## 4. One-step equations: multiplying and dividing

When the variable is multiplied by a number, divide both sides by that number. When it is divided by a number, multiply both sides by that number.

**E****Example 3: multiplication and division**

Solve  $8m = 56$ . Divide both sides by 8:  $m = 56 \div 8 = 7$ .

Solve  $\frac{z}{4} = 9$ . Multiply both sides by 4:  $z = 9 \times 4 = 36$ . Check:  $36 \div 4 = 9$ .

Solve  $1.5k = 6$ . Divide both sides by 1.5:  $k = 4$ . Check:  $1.5 \times 4 = 6$ .

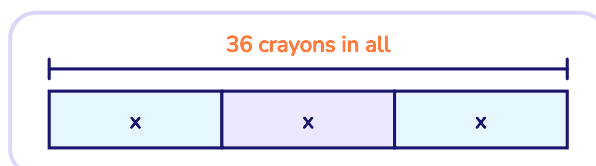
**Tip from Zyro**

On my planet we always finish with a check. Put your answer back into the original equation: if both sides match, you can trust it!

**5. Writing equations from word problems**

To turn a story into an equation, choose a letter for the unknown, find the key words, and write the relationship.

- “more than”, “total”, “increased by” suggest addition;
- “less than”, “left”, “decreased by” suggest subtraction;
- “times”, “each”, “equal groups” suggest multiplication;
- “shared equally”, “split into” suggest division.



A tape diagram helps: here three equal boxes hold 36 crayons in all, so  $3x = 36$  and  $x = 12$  crayons per box.

**E****Example 4: from a story to an answer**

Lena had some marbles. She won 15 more and now has 42. Let  $m$  be the number she had at first. Equation:  $m + 15 = 42$ . Subtract 15:  $m = 27$ . **Answer:** she had 27 marbles at first.

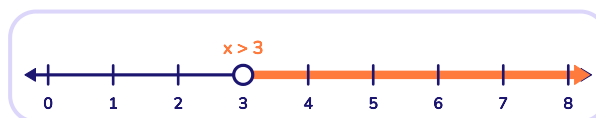
**Watch out**

“7 less than a number” is written  $n - 7$ , not  $7 - n$ . The order matters for subtraction.

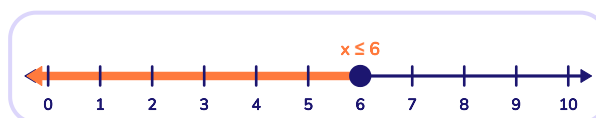
## 6. Inequalities on a number line

An **inequality** compares two quantities that may be different. The symbols are  $<$  (less than),  $>$  (greater than),  $\leq$  (less than or equal to) and  $\geq$  (greater than or equal to).

An inequality such as  $x > 3$  has *infinitely many* solutions: 3.1, 4, 7.5, 100, and so on. We show them all on a number line. An **open circle** means the endpoint is *not* included ( $<$  or  $>$ ). A **closed circle** means it is included ( $\leq$  or  $\geq$ ). The shaded ray points toward the solutions.



Here 3 is not a solution (open circle), but 4 is.



Here 6 is a solution (closed circle), and so are 5, 2.5 and 0.

## 7. Solving one-step inequalities

Solving an inequality works like solving an equation: use the inverse operation on both sides. With positive numbers, the direction of the symbol does not change.

### E Example 5: solving inequalities

Solve  $x + 9 > 20$ . Subtract 9 from both sides:  $x > 11$ .

Solve  $5n \leq 35$ . Divide both sides by 5:  $n \leq 7$ . Check with 7:  $5 \times 7 = 35 \leq 35$ , true. Check with 10:  $50 \leq 35$  is false, so 10 is outside the solution set.

### P Property

If you add or subtract the same number on both sides of an inequality, or multiply or divide both sides by the same *positive* number, the solutions stay the same.

## 8. Writing inequalities from context

Some words tell you which symbol to use.

| Words                           | Symbol |
|---------------------------------|--------|
| more than, greater than, over   | $>$    |
| less than, fewer than, under    | $<$    |
| at least, no less than, minimum | $\geq$ |
| at most, no more than, maximum  | $\leq$ |

**E****Example 6: a speed limit and a budget**

A bridge allows trucks that weigh at most 8 tons. Let  $w$  be a truck's weight in tons:  $w \leq 8$ . A truck of 7.5 tons may cross; one of 8.2 tons may not.

Nora has \$30 and wants a game that costs at least \$45. She must save  $s$  more dollars:  $30 + s \geq 45$ , so  $s \geq 15$ . She needs to save at least \$15.

**Key takeaways**

- A variable is a letter that stands for a number; a solution makes an equation true.
- To solve a one-step equation, use the inverse operation on both sides, then check.
- To write an equation, name the unknown and translate the key words.
- An inequality has many solutions; an open circle excludes the endpoint and a closed circle includes it.
- “At least” means  $\geq$  and “at most” means  $\leq$ .
- With positive numbers, solve an inequality exactly like an equation.

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