



Expressions and Equations: Solving for the Unknown

Four focused lessons, worked examples, a mistake clinic, and 60 practice problems with full explanations.

In this booster

05.1 Variables and Algebraic Expressions

05.2 One-Step and Two-Step Equations

05.3 Multi-Step Equations

05.4 Inequalities and Their Graphs

Every section teaches the idea, walks through the most common problem types, flags the traps students fall into, and ends with fifteen practice problems. Full answers and explanations are at the back.

05.1 Variables and Algebraic Expressions

Learn to read, evaluate, and simplify algebraic expressions. You will practice combining like terms and using the distributive property, the toolkit for every equation you will solve later.

Why This Matters

Algebra is the language that lets us describe a pattern once and use it again and again. A cell phone plan, the cost of a pizza party, the distance a bike rider travels: each can be written as a short expression with a letter standing in for a number that can change. Students get stuck here for three main reasons. First, a letter looks like a mystery, so they forget it is just a number in disguise. Second, they combine terms that are not alike, such as adding $3x$ and 4 to get $7x$. Third, they forget to multiply every term inside parentheses when they distribute.

Everything later in math depends on this skill: solving equations, graphing lines, working with formulas in science, and even writing spreadsheet rules. Master expressions now and the rest of the unit will feel much lighter.

Core Ideas

A **variable** is a letter that stands for a number that can change or is not yet known. An **algebraic expression** is a math phrase made of numbers, variables, and operations, with no equals sign. For example, $5n + 2$ is an expression. When you write a number next to a letter, such as $5n$, it means multiply: 5 times n .

Parts of an Expression

A **term** is a piece of an expression separated by plus or minus signs. In $5n + 2$ the terms are $5n$ and 2.

The **coefficient** is the number multiplied by the variable. In $5n$ the coefficient is 5. A term with no variable is a **constant**.

To **evaluate** an expression, replace each variable with the number you are given, then follow the order of operations: parentheses, exponents, multiplication and division from left to right, then addition and subtraction from left to right. Putting the replacement number in parentheses first is a great habit, especially for negative numbers.

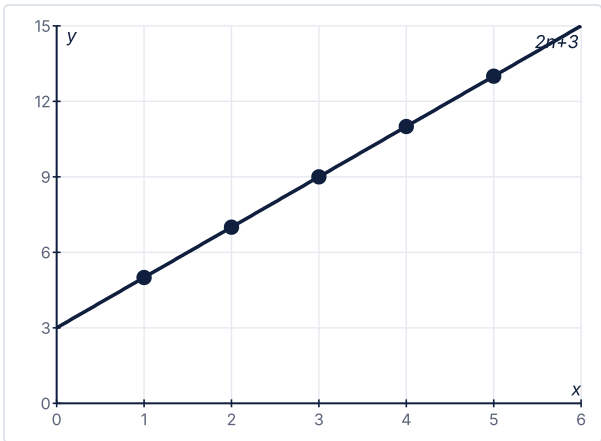
n	1	2	3	4	5
$2n + 3$	5	7	9	11	13

The table shows the expression $2n + 3$ evaluated for five values of n . Each time n goes up by 1, the value goes up by 2, because the coefficient is 2. The graph below shows the same values as points on a line.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →



Values of $2n + 3$ for $n = 1$ to 5 climb by 2 each step.

Like Terms

Like terms have exactly the same variable part (same letters with the same exponents). Only the coefficients can differ. You may add or subtract like terms by adding or subtracting their coefficients: $7x - 3x = 4x$. Terms that are not alike, such as $3x$ and $3x^2$ or $3x$ and 3 , cannot be combined.

Think of like terms as like objects. Three apples plus four apples is seven apples, but three apples plus four oranges is just three apples and four oranges. Constants are all like each other, so $9 - 4 = 5$ can always be combined.

The Distributive Property

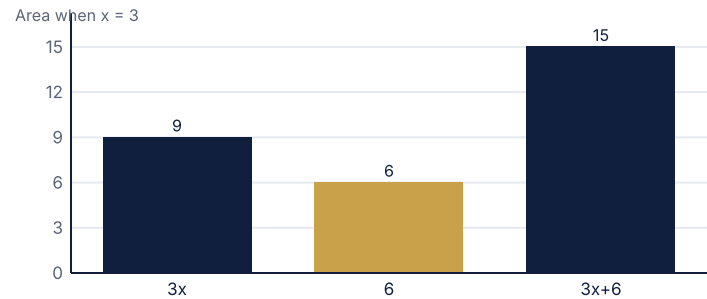
For any numbers a , b , and c :

$$a(b + c) = ab + ac \quad \text{and} \quad a(b - c) = ab - ac.$$

Multiply the outside number by EVERY term inside the parentheses, keeping the signs.

Expression	Terms	Simplified
$4x + 3x$	$4x, 3x$	$7x$
$5y + 2 - y + 6$	$5y, 2, -y, 6$	$4y + 8$
$2(x + 7)$	$2x, 14$	$2x + 14$
$-3(a - 2)$	$-3a, +6$	$-3a + 6$

Why does distributing work? Picture a rectangle that is 3 units tall and $x + 2$ units wide. Its area is $3(x + 2)$. You can also cut it into two smaller rectangles, one that is 3 by x and one that is 3 by 2 , with areas $3x$ and 6 . Both ways must give the same total, so $3(x + 2) = 3x + 6$. This area picture is the reason every term inside the parentheses must be multiplied.



With $x = 3$, the two small rectangles have areas 9 and 6 . Together they give 15 , which equals $3(3+2)$.

Another idea that helps is **equivalent expressions**. Two expressions are equivalent if they give the same value for every possible number. Simplifying never changes the value of an expression, it only rewrites it in a shorter, cleaner way. That is why a test value is such a reliable check: if the two forms ever disagree, you have made a mistake somewhere.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

When an expression has a minus sign in front of a parenthesis, treat that minus sign as multiplication by -1 . Then $-(2x - 5)$ becomes $-1 \cdot 2x + (-1)(-5) = -2x + 5$. Every sign inside flips. Writing the -1 explicitly is a simple way to avoid the most common sign slip in the whole unit.

Here is a quick way to tell whether two terms can be combined: ask whether they have the exact same letters with the exact same exponents. $5ab$ and $2ab$ do, so $5ab + 2ab = 7ab$. But $5ab$ and $5a$ do not, and neither do $4x^2$ and $4x$. If you are unsure, plug in a number such as $x = 2$ and see whether the two sides disagree.

Finally, remember that a letter can stand for ANY number, so an expression is like a recipe that works for many inputs. The expression $6m + 2$ gives the cost for 1 pizza box, 10 boxes, or 100 boxes, just by changing m . That is the real power of algebra: one short rule that describes endlessly many situations.

Worked Examples

EXAMPLE 1

Evaluate $4x - 3y$ when $x = 5$ and $y = 2$.

SOLUTION

Replace each letter with its value: $4(5) - 3(2)$.

Multiply first: $20 - 6$.

Subtract: 14.

EXAMPLE 2

Evaluate $2n^2 - 3n + 1$ when $n = -2$.

SOLUTION

Put the number in parentheses: $2(-2)^2 - 3(-2) + 1$.

Exponent first: $(-2)^2 = 4$, so $2(4) - 3(-2) + 1$.

Multiply: $8 + 6 + 1$. Subtracting a negative adds.

The value is 15.

EXAMPLE 3

Simplify by combining like terms: $5x + 3y - 2x + 7 + 4y - 9$.

SOLUTION

Group by type: the x terms are $5x$ and $-2x$; the y terms are $3y$ and $4y$; the constants are 7 and -9 .

Combine: $(5x - 2x) + (3y + 4y) + (7 - 9)$.

$3x + 7y - 2$. The terms $3x$, $7y$, and -2 are not alike, so we stop.

EXAMPLE 4

Simplify $3(2x - 5) + 4$.

SOLUTION

Distribute the 3 to both terms inside: $3 \cdot 2x = 6x$ and $3 \cdot (-5) = -15$.

Now we have $6x - 15 + 4$.

Combine the constants: $-15 + 4 = -11$.

The answer is $6x - 11$.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

EXAMPLE 5Simplify $4(x + 3) - 2(3x - 1)$.**SOLUTION**Distribute 4: $4x + 12$.Distribute -2 to both terms in the second set. $-2 \cdot 3x = -6x$ and $-2 \cdot (-1) = +2$. So we get $-6x + 2$.Put it together: $4x + 12 - 6x + 2$.Combine x terms: $4x - 6x = -2x$. Combine constants: $12 + 2 = 14$.The answer is $-2x + 14$.**EXAMPLE 6**Simplify $-(3x - 2) + 5(x + 1) - 4x$, then evaluate your answer when $x = 3$.**SOLUTION**Write the minus sign as -1 and distribute: $-(3x - 2) = -3x + 2$.Distribute 5: $5(x + 1) = 5x + 5$.Put it together: $-3x + 2 + 5x + 5 - 4x$.Combine x terms: $-3x + 5x - 4x = -2x$. Combine constants: $2 + 5 = 7$. The simplified form is $-2x + 7$.Evaluate at $x = 3$: $-2(3) + 7 = 1$. Check with the original: $-(9 - 2) + 5(4) - 12 = -7 + 20 - 12 = 1$. They match.**Coach's Playbook**

- 1 Rewrite with parentheses.** When evaluating, write each replacement number inside parentheses so negatives and exponents behave.
- 2 Circle the sign.** Each term owns the sign in front of it. Circle terms with their signs before you combine.
- 3 Sort the terms.** Underline x terms one way, y terms another way, and box the constants.
- 4 Distribute to every term.** Draw an arrow from the outside number to each term inside the parentheses.
- 5 Check with a test value.** Pick an easy number such as $x = 1$. Your original and simplified expressions must give the same result.

Order of operations matters when you evaluate. In $3 + 4x$ with $x = 2$, do the multiplication first: $3 + 8 = 11$, not $7 \cdot 2 = 14$. If a problem has both parentheses and exponents, work inside the parentheses first, then apply the exponent, then multiply, and finally add or subtract. Slow, tidy steps beat fast, messy ones every time.

The test value check is a powerful safety net. For Example 4, try $x = 2$: the original gives $3(2 \cdot 2 - 5) + 4 = 3(-1) + 4 = 1$, and the answer gives $6(2) - 11 = 1$. They match, so the work is right.

Common traps

1) Combining unlike terms, such as $3x + 4 = 7x$. 2) Distributing only to the first term: $3(x + 2) = 3x + 2$ is wrong; it is $3x + 6$. 3) Forgetting that a negative outside the parentheses flips the signs inside: $-(x - 4) = -x + 4$. 4) Treating -3^2 or $(-3)^2$ the same way; $(-3)^2 = 9$.

Mistake Clinic**Spot the error**

Wrong work: $3(x + 4) = 3x + 4$. Where it went wrong: the 3 was multiplied by x but not by 4. The outside number multiplies EVERY term inside. Right solution: $3(x + 4) = 3x + 12$.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

Spot the error

Wrong work: $5x + 3 = 8x$. Where it went wrong: $5x$ has a variable and 3 does not, so they are not like terms. They cannot be merged. Right solution: $5x + 3$ is already simplified. Test it with $x = 1$: $5 + 3 = 8$, but $8x$ gives 8 only by luck; try $x = 2$ and you get 13 versus 16.

Spot the error

Wrong work: Evaluate $2x^2$ when $x = 5$: $(2 \cdot 5)^2 = 100$. Where it went wrong: the exponent belongs only to x , not to the 2. Do the exponent first. Right solution: $2 \cdot 5^2 = 2 \cdot 25 = 50$.

Real-World Connection

A bakery sells muffins for 3 dollars each and a drink for 2 dollars. The cost of m muffins and one drink is $3m + 2$ dollars. For 6 muffins, evaluate: $3(6) + 2 = 20$ dollars.

Challenge Corner

A triangle has sides $(2x + 1)$ cm, $3(x - 2)$ cm, and $(4x - 5)$ cm. Write a simplified expression for its perimeter, then find the perimeter when $x = 6$. Solution: Perimeter is the sum of the sides: $2x + 1 + 3(x - 2) + 4x - 5$. Distribute: $2x + 1 + 3x - 6 + 4x - 5$. Combine x terms: $9x$. Combine constants: $1 - 6 - 5 = -10$. The perimeter is $9x - 10$. At $x = 6$ the sides are 13, 12, and 19 cm, and the perimeter is $9(6) - 10 = 44$ cm.

Practice**PRACTICE Variables and Algebraic Expressions**

Show your work on paper. Use a calculator only when a problem says so, or if it is allowed at your level.

- What is the value of $5m - 2$ when $m = 6$?
(A) 32 (B) 28 (C) 62 (D) 4
- Which term is a like term of $4x^2y$?
(A) $4xy^2$ (B) $4x^2$ (C) $7x^2y$ (D) $4xy$
- Simplify $7a + 2b - 3a + 5b$.
(A) $10a + 7b$ (B) $4a + 3b$ (C) $11ab$ (D) $4a + 7b$
- Which expression equals $5(2x - 3)$?
(A) $10x - 15$ (B) $10x - 3$ (C) $10x + 15$ (D) $7x - 8$
- What is the value of $x^2 - 3x$ when $x = -4$?
(A) -4 (B) 4 (C) 28 (D) -28
- Simplify $6(x + 2) - 3(x - 4)$.
(A) $3x$ (B) $3x + 24$ (C) $9x + 24$ (D) $3x + 8$
- What is the value of $3(a + 2) - a$ when $a = 5$?
(A) 12 (B) 21 (C) 10 (D) 16
- Simplify $4(2y - 3) - (y - 5)$.
(A) $7y - 17$ (B) $9y - 7$ (C) $7y - 7$ (D) $7y - 12$
- Which expression is equivalent to $2(3x + 4) - 6x + 1$?
(A) 9 (B) $12x + 9$ (C) $9x$ (D) $6x + 9$
- Simplify $2(4x - 1) + 3(x + 5)$.
- Evaluate $\frac{a^2 + 3b}{c}$ when $a = 4$, $b = -2$, and $c = 5$.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

12. A rectangle has length $(3x + 4)$ cm and width $(x - 1)$ cm. Write a simplified expression for its perimeter, then find the perimeter when $x = 6$.
13. Simplify $-3(2x - 4) - (5 - x) + 2x$.
14. Simplify $7 - 2(x - 3) + 4x$.
15. A box holds m muffins and 2 cookies. Sam buys 4 boxes, then 3 extra muffins and 5 extra cookies. Write a simplified expression for the total number of items, then find the total when $m = 6$.

05.2

One-Step and Two-Step Equations

Use inverse operations and the balance model to solve one-step and two-step equations, then check each answer. You will also turn short stories into equations and solve them.

Why This Matters

An equation is a puzzle that says two things are equal and asks you to find the unknown number that makes the statement true. Solving equations lets you answer questions like: How many weeks until I can afford a new game console? How long must I run to reach my training goal? Which ticket price breaks even? Engineers, nurses, cooks, and coders all solve equations every day. Students get stuck for predictable reasons. They do the wrong operation (adding when they should subtract), they do something to only one side of the equation, or they undo the steps in the wrong order. The good news is that one idea fixes all three: keep the equation balanced, and undo operations using their opposites.

Core Ideas

An **equation** has an equals sign. A **solution** is a number that makes the equation true when you put it in place of the variable. To **solve** an equation means to get the variable alone on one side.

The Balance Rule

Whatever you do to one side of an equation, you must do to the other side. The two sides stay equal. Adding, subtracting, multiplying, or dividing both sides by the same number (not zero for multiplying or dividing) never changes the solution.

Imagine a balance scale. If the left pan holds $x + 3$ and the right pan holds 10, the scale is level. Take 3 away from both pans and the scale stays level: $x = 7$. This **balance model** is why every move in algebra is done on both sides.

Inverse Operations

Operations that undo each other are **inverse operations**. Addition and subtraction are inverses. Multiplication and division are inverses. To get a variable alone, apply the inverse of whatever is being done to it.

Equation	What is done to x	Undo with	Result
$x + 5 = 12$	add 5	subtract 5 from both sides	$x = 7$
$x - 4 = 9$	subtract 4	add 4 to both sides	$x = 13$
$3x = 18$	multiply by 3	divide both sides by 3	$x = 6$
$\frac{x}{2} = 5$	divide by 2	multiply both sides by 2	$x = 10$

A **two-step equation** such as $2x + 3 = 11$ has two operations on the variable: first it is multiplied by 2, then 3 is added. To undo them, reverse the order. Think of getting dressed: socks then shoes. To undo, take off shoes first, then socks. So undo the addition or subtraction first, then undo the multiplication or division.

Solving a Two-Step Equation

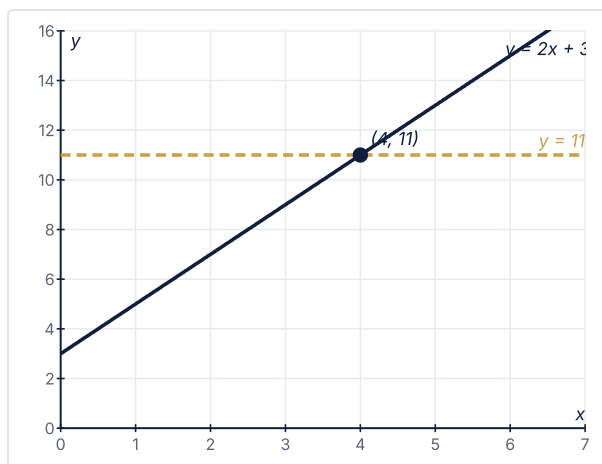
- Step 1: Undo the addition or subtraction on both sides.
- Step 2: Undo the multiplication or division on both sides.
- Step 3: Check by putting your answer back into the original equation.

The graph shows why this works. The line $y = 2x + 3$ rises as x increases. Solving $2x + 3 = 11$ means finding the x value where the line reaches height 11. The line and the horizontal line $y = 11$ meet at $x = 4$.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →



The solution of $2x + 3 = 11$ is where the two graphs meet: $x = 4$.

x	1	2	3	4	5
$2x + 3$	5	7	9	11	13

The table of values tells the same story. Only $x = 4$ makes $2x + 3$ equal to 11. Checking a solution is just a quick test of this kind: replace the variable and see whether both sides match.

Here is a mental picture for the whole process. A two-step equation is a short machine: the input x goes in, gets multiplied, then gets added to, and the output comes out. Solving the equation means running the machine backward from the output. If $2x + 3$ gave 11, then going backward we take away 3 to get 8, then split 8 into two equal parts to get 4. Each backward step uses the inverse operation.



The solution of $2x + 9 = 25$ is the single point $x = 8$ on the number line.

A solution is always a single number for these equations, so on a number line it is one point. Later in this unit you will meet inequalities, where the solution can be a whole stretch of the line, but the same balance idea still applies.

Some equations have the variable on the right, such as $9 = 2x - 5$. This is perfectly fine: an equals sign works in both directions, so $9 = 2x - 5$ means the same as $2x - 5 = 9$. You may solve it as written or flip the sides first. The balance idea does not change.

Worked Examples

EXAMPLE 1

Solve $x + 9 = 17$.

SOLUTION

The variable has 9 added to it. Subtract 9 from both sides.

$$x + 9 - 9 = 17 - 9, \text{ so } x = 8.$$

Check: $8 + 9 = 17$. True.

EXAMPLE 2

Solve $\frac{n}{4} = 7$.

SOLUTION

The variable is divided by 4. Multiply both sides by 4.

$$n = 7 \cdot 4 = 28.$$

Check: $28 \div 4 = 7$. True.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

EXAMPLE 3

Solve $3x + 5 = 23$.

SOLUTION

Undo the addition first: subtract 5 from both sides. $3x = 18$.

Undo the multiplication: divide both sides by 3. $x = 6$.

Check: $3(6) + 5 = 18 + 5 = 23$. True.

EXAMPLE 4

Mia has 15 dollars saved. She adds 6 dollars each week. After how many weeks will she have 63 dollars?

SOLUTION

Let w be the number of weeks. The equation is $6w + 15 = 63$.

Subtract 15: $6w = 48$.

Divide by 6: $w = 8$.

Mia reaches 63 dollars after 8 weeks. Check: $6(8) + 15 = 63$.

EXAMPLE 5

Solve $-4x + 7 = -21$.

SOLUTION

Subtract 7 from both sides: $-4x = -28$.

Divide both sides by -4 . A negative divided by a negative is positive: $x = 7$.

Check: $-4(7) + 7 = -28 + 7 = -21$. True.

EXAMPLE 6

Solve $\frac{x+3}{2} = 7$.

SOLUTION

The whole expression $x + 3$ is divided by 2. Undo the division first: multiply both sides by 2 to get $x + 3 = 14$.

Subtract 3: $x = 11$.

Check: $\frac{11+3}{2} = \frac{14}{2} = 7$. True.

Coach's Playbook

- 1 Spot the order.** Look at what is done to the variable and in what order. Multiplication or division is done first, then the add or subtract.
- 2 Undo in reverse.** Start with the term that is added or subtracted, then handle the coefficient.
- 3 Do it to both sides.** Write the same operation under each side so nothing is forgotten.
- 4 Keep the equals signs lined up.** One equation per line makes errors easy to spot.
- 5 Always check.** Put your answer into the original equation. If both sides match, you are done.

When the answer is not a whole number, that is fine. For $5x + 2 = 14$ you get $5x = 12$, so $x = \frac{12}{5} = 2.4$. Leave a fraction or decimal; do not force a whole number. If a variable has a negative coefficient, remember that you divide by the negative number, which changes the sign of the right side.

For word problems, define your variable in a sentence first, such as "Let w = number of weeks." Then your equation tells a story you can read back to check that it makes sense. A solution like $w = -3$ weeks or $w = 2.5$ buses would signal a mistake in the setup.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

Common traps

1) Dividing first in $3x + 5 = 23$ but only dividing the $3x$ term. If you divide, you must divide EVERY term on both sides. 2) Changing only one side: $x + 6 = 10$ becomes $x = 10$. 3) Adding when you should subtract: the inverse of $+6$ is -6 . 4) Losing a negative sign when dividing: $-4x = -28$ gives $x = 7$, not -7 .

Mistake Clinic**Spot the error**

Wrong work: $3x + 5 = 23$, so $3x = 23 + 5 = 28$ and $x = \frac{28}{3}$. Where it went wrong: the 5 is added on the left, so it must be SUBTRACTED from both sides. Right solution: $3x = 23 - 5 = 18$, so $x = 6$.

Spot the error

Wrong work: $\frac{x}{4} = 7$, so $x = 7 - 4 = 3$. Where it went wrong: the variable is divided by 4, and the inverse of dividing is multiplying, not subtracting. Right solution: $x = 7 \cdot 4 = 28$. Check: $28 \div 4 = 7$.

Spot the error

Wrong work: $-4x = -28$, so $x = -7$. Where it went wrong: dividing a negative by a negative gives a positive. Right solution: $x = \frac{-28}{-4} = 7$. Check: $-4(7) = -28$.

Real-World Connection

A taxi charges a 4 dollar flat fee plus 2 dollars per mile. For a 14 dollar ride, solve $2m + 4 = 14$ to get $m = 5$ miles.

Challenge Corner

A car rental costs 18 dollars plus 0.75 dollars per mile. Jin has a 3 dollar coupon that is taken off the bill, and the final bill is 46.50 dollars. How many miles did Jin drive? Solution: Let m be miles. The bill is $18 + 0.75m - 3 = 46.50$. Combine constants: $0.75m + 15 = 46.50$. Subtract 15: $0.75m = 31.50$. Divide by 0.75: $m = 42$. Check: $18 + 31.50 - 3 = 46.50$.

Practice**PRACTICE One-Step and Two-Step Equations**

Show your work on paper. Use a calculator only when a problem says so, or if it is allowed at your level.

- | | | | | |
|----------------------------------|---------|---------|----------|-------------------|
| 1. Solve $x - 7 = 12$. | (A) 5 | (B) -5 | (C) 19 | (D) 84 |
| 2. Solve $6n = 42$. | (A) 36 | (B) 7 | (C) 48 | (D) 252 |
| 3. Solve $\frac{m}{3} = 8$. | (A) 24 | (B) 11 | (C) 5 | (D) $\frac{8}{3}$ |
| 4. Solve $2x + 9 = 25$. | (A) 17 | (B) 16 | (C) 12.5 | (D) 8 |
| 5. Solve $5x - 8 = 27$. | (A) 3.8 | (B) 35 | (C) 7 | (D) -7 |
| 6. Solve $\frac{x}{4} + 6 = 2$. | (A) 16 | (B) -16 | (C) 32 | (D) -1 |

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

7. Solve $9 = 2x - 5$.
 (A) 2 (B) 14 (C) 7 (D) -7
8. Solve $\frac{y}{5} - 3 = -1$.
 (A) -20 (B) 10 (C) 2 (D) -10
9. A taxi charges a 3 dollar base fee plus 2.50 dollars per mile. A ride cost 18 dollars. How many miles was the ride?
 (A) 6 (B) 7.5 (C) 8.4 (D) 15
10. Solve $7x + 4 = -24$.
11. Solve $-3x + 11 = 2$.
12. A gym charges a joining fee of 25 dollars plus 12 dollars per month. Maya has paid a total of 109 dollars. Write an equation and find how many months she has been a member.
13. Solve $\frac{2}{3}x - 5 = 7$.
14. Solve $-\frac{x}{3} + 4 = 9$.
15. A pool holds 120 gallons and drains at 8 gallons per minute. After how many minutes will 40 gallons remain?

05.3 Multi-Step Equations

Solve equations with variables on both sides, parentheses, fractions, and decimals. You will also learn what it means when an equation has no solution or infinitely many solutions.

Why This Matters

Real equations rarely come in the neat form $3x + 5 = 23$. A cell phone plan, a gym membership, and a school fundraiser might all change at different rates, so the unknown shows up on both sides of the equals sign. Multi-step equations are where algebra starts to feel like real problem solving. The skills here, such as distributing, clearing fractions, and keeping signs straight, are used again in graphing lines, solving systems, and every science class that uses formulas.

Students most often get stuck in four places: forgetting to distribute to every term, moving a term across the equals sign with the wrong sign, being frightened of fractions and decimals, and not knowing what to do when the variable disappears completely. This section tackles each one with a clear routine.

Core Ideas

A multi-step equation needs more than two moves to solve. The reliable way to handle them is to simplify each side first, then collect the variable terms on one side, then finish with the two-step method you already know.

The Multi-Step Routine

- 1) **Clear parentheses** using the distributive property.
- 2) **Combine like terms** on each side separately.
- 3) **Move variable terms** to one side and constants to the other by adding or subtracting the same thing on both sides.
- 4) **Divide** by the coefficient of the variable.
- 5) **Check** in the original equation.

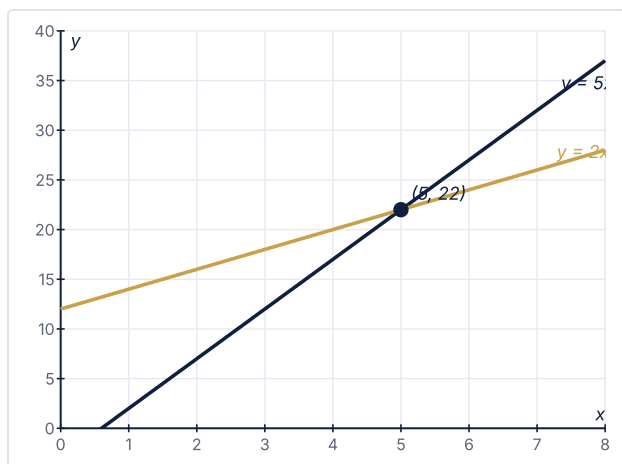
When the variable appears on both sides, pick one side to keep the variable. A good habit is to move the smaller variable term so that the coefficient stays positive. For $5x - 3 = 2x + 12$, subtract $2x$ from both sides to get $3x - 3 = 12$, then add 3 to get $3x = 15$, so $x = 5$.

The graphs of the two sides tell the story. Let the left side be the line $y = 5x - 3$ and the right side be $y = 2x + 12$. The solution of the equation is the x value where the two lines are at the same height. They cross at $(5, 22)$.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →



Both sides of $5x - 3 = 2x + 12$ equal 22 when $x = 5$.

Clearing Fractions and Decimals

To remove fractions, multiply **every term** on both sides by the **least common denominator** (LCD).

To remove decimals, multiply every term by 10, 100, or 1000 so that all the decimals become whole numbers.

Then solve the resulting whole-number equation as usual.

Equation	Multiply by	Becomes
$\frac{x}{2} + \frac{x}{3} = 10$	6	$3x + 2x = 60$
$0.5x + 1.2 = 0.2x + 3$	10	$5x + 12 = 2x + 30$
$\frac{x}{4} - 1 = \frac{x}{2}$	4	$x - 4 = 2x$

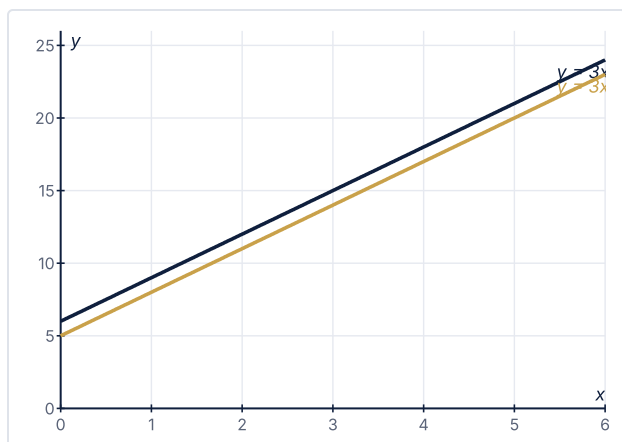
Three Possible Outcomes

One solution: the variable ends up with a number, like $x = 5$.

No solution: the variable disappears and you get a FALSE statement, like $0 = 1$ or $7 = 9$.

Infinitely many solutions: the variable disappears and you get a TRUE statement, like $6 = 6$. Every number works.

Why does this happen? If two lines have the same slope but different starting heights, they are parallel and never meet, so there is no solution. If they are the same line, every point is shared, so every number is a solution. The picture below shows the no-solution case for $3x + 6 = 3x + 5$.



Parallel lines never meet, so $3x + 6 = 3x + 5$ has no solution.

A good test for whether you really understand a method is to solve the same equation two ways. Try $4x + 6 = 2x + 12$. You can subtract $2x$ first to get $2x + 6 = 12$, or subtract $4x$ first to get $6 = -2x + 12$. Both lead to $x = 3$. Choosing the way that keeps the variable's coefficient positive usually avoids sign errors, but any legal move works.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

Worked Examples

EXAMPLE 1

Solve $5x - 3 = 2x + 12$.

SOLUTION

Subtract $2x$ from both sides: $3x - 3 = 12$.

Add 3 to both sides: $3x = 15$.

Divide by 3: $x = 5$.

Check: left side $5(5) - 3 = 22$, right side $2(5) + 12 = 22$. True.

EXAMPLE 2

Solve $3(x + 4) = 2x + 20$.

SOLUTION

Distribute the 3: $3x + 12 = 2x + 20$.

Subtract $2x$ from both sides: $x + 12 = 20$.

Subtract 12: $x = 8$.

Check: $3(12) = 36$ and $2(8) + 20 = 36$. True.

EXAMPLE 3

Solve $\frac{x}{2} + \frac{x}{3} = 10$.

SOLUTION

The LCD of 2 and 3 is 6. Multiply every term by 6: $6 \cdot \frac{x}{2} + 6 \cdot \frac{x}{3} = 6 \cdot 10$.

This gives $3x + 2x = 60$, so $5x = 60$.

Divide by 5: $x = 12$.

Check: $6 + 4 = 10$. True.

EXAMPLE 4

Solve $0.5x + 1.2 = 0.2x + 3$.

SOLUTION

Multiply every term by 10 to clear the decimals: $5x + 12 = 2x + 30$.

Subtract $2x$: $3x + 12 = 30$. Subtract 12: $3x = 18$.

Divide by 3: $x = 6$.

Check: $0.5(6) + 1.2 = 4.2$ and $0.2(6) + 3 = 4.2$. True.

EXAMPLE 5

Solve each equation and say how many solutions it has. (a) $3(x + 2) = 3x + 5$ (b) $2(x + 3) = 2x + 6$

SOLUTION

(a) Distribute: $3x + 6 = 3x + 5$. Subtract $3x$ from both sides: $6 = 5$. This is false, so there is **no solution**.

(b) Distribute: $2x + 6 = 2x + 6$. Subtract $2x$: $6 = 6$. This is always true, so there are **infinitely many solutions**; any number works.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

EXAMPLE 6

Solve $7 - 2x = 3x + 17$.

SOLUTION

Add $2x$ to both sides so the variable term is positive: $7 = 5x + 17$.

Subtract 17: $-10 = 5x$.

Divide by 5: $x = -2$.

Check: left $7 - 2(-2) = 11$. Right $3(-2) + 17 = 11$. True.

Coach's Playbook

- 1 Simplify each side first.** Distribute and combine like terms on the left, then on the right, before moving anything across.
- 2 Choose a side for the variable.** Move the smaller variable term so the coefficient stays positive.
- 3 Clear fractions early.** Multiply every term by the LCD. Write the multiplier under EACH term so none is missed.
- 4 Use a check column.** Substitute your answer into the original equation, not your last line.
- 5 Read the ending.** A number means one solution. A false statement means none. A true statement means infinitely many.

Two memory tricks help. First, move terms by doing the opposite operation on both sides rather than saying "switch sides, change sign"; the first version always makes sense. Second, when a negative sign is in front of parentheses, write -1 before it so you do not forget to flip every sign inside.

Common traps

1) Distributing to only the first term: $3(x + 4) = 3x + 4$ is wrong. 2) Multiplying only some terms by the LCD and leaving others alone. 3) Subtracting a term from one side only. 4) Stopping at $0 = 0$ and saying the answer is $x = 0$. A true statement like this means every number is a solution.

Mistake Clinic**Spot the error**

Wrong work: $2(x + 3) = 14$, so $2x + 3 = 14$ and $x = 5.5$. Where it went wrong: the 2 was not multiplied by the 3. Right solution: $2x + 6 = 14$, so $2x = 8$ and $x = 4$.

Spot the error

Wrong work: $5x - 2 = 3x + 8$, so $5x - 3x = 8 - 2$ and $x = 3$. Where it went wrong: the -2 moves to the right side by ADDING 2, not subtracting. Right solution: $2x = 10$, so $x = 5$. Check: $23 = 23$.

Spot the error

Wrong work: $3(x - 1) = 3x - 3$ becomes $0 = 0$, so $x = 0$. Where it went wrong: $0 = 0$ is a true statement with no variable left, which means every number works. Right solution: infinitely many solutions.

Real-World Connection

Plan A costs 20 dollars plus 0.10 dollars per text. Plan B costs 8 dollars plus 0.20 dollars per text. They cost the same when $20 + 0.1t = 8 + 0.2t$, so $12 = 0.1t$ and $t = 120$ texts.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

Challenge Corner

For what value of k does $3(2x + 1) = kx + 5$ have no solution? What is the solution when $k = 5$? Solution: Distribute: $6x + 3 = kx + 5$. If $k = 6$, subtracting $6x$ leaves $3 = 5$, which is false, so there is no solution. If $k = 5$: $6x + 3 = 5x + 5$, so $x = 2$. Check: $3(5) = 15$ and $5(2) + 5 = 15$.

Practice**PRACTICE Multi-Step Equations**

Show your work on paper. Use a calculator only when a problem says so, or if it is allowed at your level.

- Solve $4x + 3 = 2x + 11$.
(A) $\frac{7}{3}$ (B) -4 (C) 8 (D) 4
- Solve $3(x - 2) = 15$.
(A) 7 (B) 3 (C) 5 (D) $\frac{17}{3}$
- Solve $2(x + 5) - 3 = x + 9$.
(A) 7 (B) 16 (C) 2 (D) -2
- Solve $\frac{x}{3} + \frac{x}{4} = 14$.
(A) 6 (B) 24 (C) 98 (D) 12
- Solve $0.6x - 1.5 = 0.2x + 0.5$.
(A) 2.5 (B) 50 (C) 5 (D) 20
- Which equation has no solution?
(A) $4x + 1 = 4x + 7$ (B) $4x + 1 = 4x + 1$ (C) $4x + 1 = 7x + 1$
(D) $4x + 1 = -4x + 1$
- Solve $6 - 3x = 2x + 21$.
(A) 3 (B) -3 (C) -5 (D) -7.5
- Solve $\frac{x}{2} - \frac{x}{5} = 3$.
(A) 30 (B) 6 (C) 10 (D) 1.5
- For which value of k does $4x + 9 = kx + 9$ have infinitely many solutions?
(A) 9 (B) 0 (C) 13 (D) 4
- Solve $5x - 4 = 3x + 10$.
- Solve $4(2x - 3) = 3(x + 6)$.
- Solve $\frac{x}{2} - \frac{1}{3} = \frac{x}{6} + 1$.
- Find the value of k that makes $5(x - 2) = 5x + k$ have infinitely many solutions.
- Solve $2(3x - 4) - 5 = 4(x + 1) + 1$.
- Solve $0.25x + 0.5 = 0.75x - 2$.

05.4 Inequalities and Their Graphs

Solve inequalities, remember when to reverse the sign, and graph solutions on a number line. You will also handle compound inequalities and real-world limits.

Why This Matters

Life is full of limits and minimums, not just exact amounts. You need at least 90 percent to earn an A. An elevator holds at most 12 people. A plane ticket must cost less than your budget. Each of these is an **inequality**, a statement that compares two quantities that are not necessarily equal. Inequalities are used in budgeting, safety rules, science experiments, and computer programs that check conditions.

Students struggle with inequalities in three places. They forget to reverse the sign when multiplying or dividing by a negative number. They mix up open and closed circles on a number line. And they confuse words like "at least" and "at most" when reading a story. This section gives you a clear rule and a picture for each one.

Core Ideas

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

Inequality Symbols

$a < b$ means a is less than b . $a > b$ means a is greater than b .
 $a \leq b$ means a is less than or equal to b . $a \geq b$ means a is greater than or equal to b .
 Key phrases: "at least" means $\geq$; "at most" means $\leq$; "more than" means $>$; "fewer than" means $<$.

An inequality usually has infinitely many solutions. For $x < 7$, the numbers 6, 3, 0, -10 , and 6.99 all work. We show the whole set of solutions with a **number line graph**. Use an **open circle** when the endpoint is NOT included ($<$ or $>$) and a **closed circle** when it IS included ($\leq$ or $\geq$). Shade in the direction of the solutions.



The graph of $x < 7$: an open circle at 7 and shading to the left.



The graph of $x \geq 5$ uses a closed circle at 5 and shading to the right.

Solving Inequalities

Solve an inequality exactly like an equation: add, subtract, multiply, or divide both sides.
Special rule: If you multiply or divide both sides by a **NEGATIVE** number, you must **REVERSE** the inequality sign.
 Example: $-2x > 8$ becomes $x < -4$.

Why does the sign flip? Start with the true statement $2 < 5$. Multiply both sides by -1 . You get -2 and -5 , and now $-2 > -5$, because -2 is farther to the right on the number line. Multiplying by a negative reverses the order of numbers, so the sign must reverse too. Adding or subtracting never changes the order, so no flip is needed there.

Operation on both sides	Reverse the sign?
Add or subtract any number	No
Multiply or divide by a positive number	No
Multiply or divide by a negative number	YES

Compound Inequalities

An **and** inequality such as $-2 < x \leq 4$ means both parts are true at once: x is between -2 and 4 . The graph is one shaded segment.
 An **or** inequality such as $x < -1$ or $x \geq 3$ means at least one part is true. The graph has two separate pieces going in opposite directions.



The graph of $-2 < x \leq 4$: open circle at -2 , closed circle at 4 , shaded between.

For a real-world constraint, the variable often cannot take every value on the line. If t is the number of tickets, the answer must be a whole number that is zero or larger. Always ask: what values make sense here? The inequality gives the math, and common sense trims the answer.

When you test a point, pick numbers that are easy to compute, such as 0, 1, or 10. Test one point in the shaded region and one outside it. For $x \leq 9$, try 0 (should work) and 10 (should fail). This two-point test catches both a wrong direction and a wrong sign flip in seconds.

Worked Examples

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

EXAMPLE 1

Solve $x + 5 < 12$ and describe the graph.

SOLUTION

Subtract 5 from both sides: $x < 7$.

No negative multiplication occurred, so the sign stays.

Graph: an open circle at 7 and shading to the left.

EXAMPLE 2

Solve $3x - 4 \geq 11$.

SOLUTION

Add 4: $3x \geq 15$.

Divide by 3 (positive, so no flip): $x \geq 5$.

Graph: a closed circle at 5 and shading to the right. Check with $x = 6$: $18 - 4 = 14 \geq 11$. True.

EXAMPLE 3

Solve $-2x + 3 > 11$.

SOLUTION

Subtract 3: $-2x > 8$.

Divide by -2 and REVERSE the sign: $x < -4$.

Check with $x = -5$: $-2(-5) + 3 = 13 > 11$. True. Check with $x = 0$: $3 > 11$ is false, which agrees, since 0 is not less than -4 .

EXAMPLE 4

Solve the compound inequality $-3 < 2x + 1 \leq 9$.

SOLUTION

Do the same step to all three parts. Subtract 1: $-4 < 2x \leq 8$.

Divide by 2: $-2 < x \leq 4$.

Graph: an open circle at -2 , a closed circle at 4, and shading between them.

EXAMPLE 5

Sam has 40 dollars. Tickets cost 6 dollars each plus a 4 dollar service fee for the whole order. How many tickets can Sam buy?

SOLUTION

Let t be the number of tickets. The total cost is $6t + 4$, which must be at most 40: $6t + 4 \leq 40$.

Subtract 4: $6t \leq 36$. Divide by 6: $t \leq 6$.

Tickets are whole numbers and cannot be negative, so $t = 0, 1, 2, 3, 4, 5, 6$. Sam can buy at most 6 tickets.

EXAMPLE 6

Solve $\frac{x}{3} - 2 \leq 1$ and describe its graph.

SOLUTION

Add 2 to both sides: $\frac{x}{3} \leq 3$.

Multiply both sides by 3 (positive, so no flip): $x \leq 9$.

Graph: a closed circle at 9 and shading to the left. Check with $x = 6$: $2 - 2 = 0 \leq 1$. True.

Coach's Playbook

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

- 1 **Translate the words.** Circle phrases like "at least" or "no more than" and write the matching symbol.
- 2 **Solve like an equation.** Use inverse operations and keep the inequality sign in place.
- 3 **Watch for the negative.** Whenever you multiply or divide by a negative, draw a box around the sign and flip it.
- 4 **Graph carefully.** Open circle for $<$ or $>$. Closed circle for $\leq$ or $\geq$. Shade toward the solutions.
- 5 **Test a point.** Pick one number from the shaded region and one from outside. The shaded one should work and the other should not.

A helpful trick: if you dislike flipping the sign, move the variable term to the side where its coefficient stays positive. For $5 - 2x > 9$, add $2x$ and subtract 9 to get $-4 > 2x$, then $-2 > x$, which reads the same as $x < -2$.

Common traps

1) Forgetting to flip the sign when dividing by a negative. 2) Using a closed circle for $<$ or an open circle for $\leq$. 3) Reading "at most" as $\geq$. 4) Writing a compound inequality like $4 < x < -2$ that can never be true; the smaller number goes on the left.

Mistake Clinic

Spot the error

Wrong work: $-3x > 12$, so $x > -4$. Where it went wrong: dividing by -3 reverses the inequality sign. Right solution: $x < -4$. Check with $x = -5$: $-3(-5) = 15 > 12$. True.

Spot the error

Wrong work: the graph of $x \geq 5$ is drawn with an open circle at 5. Where it went wrong: $\geq$ includes 5 itself, so the circle must be closed (filled in). Right solution: closed circle at 5 and shading to the right.

Spot the error

Wrong work: A bus holds at most 40 riders and 28 are aboard. The student writes $28 + r \geq 40$, so $r \geq 12$. Where it went wrong: "at most" means $\leq$. Right solution: $28 + r \leq 40$, so $r \leq 12$: at most 12 more riders.

Real-World Connection

A roller coaster sign says riders must be at least 48 inches tall. If h is height in inches, the rule is $h \geq 48$. A closed circle at 48 on the number line shows a rider exactly 48 inches tall is allowed.

Challenge Corner

Find every whole number w that satisfies BOTH $2w - 3 > 5$ and $3w + 1 \leq 22$. Solution: From the first, $2w > 8$, so $w > 4$. From the second, $3w \leq 21$, so $w \leq 7$. Together $4 < w \leq 7$. The whole numbers are 5, 6, and 7. Check $w = 7$: $2(7) - 3 = 11 > 5$ and $3(7) + 1 = 22 \leq 22$. Check $w = 8$: $3(8) + 1 = 25 > 22$, so it fails.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

Practice

PRACTICE Inequalities and Their Graphs

Show your work on paper. Use a calculator only when a problem says so, or if it is allowed at your level.

- Solve $x - 3 \geq 8$.
(A) $x \leq 11$ (B) $x \geq 5$ (C) $x \geq 11$ (D) $x > 11$
- Solve $4x < 28$.
(A) $x > 7$ (B) $x < 7$ (C) $x < 24$ (D) $x < 112$
- Solve $-5x \leq 30$.
(A) $x \leq -6$ (B) $x \leq 6$ (C) $x \geq 6$ (D) $x \geq -6$
- Solve $2x + 7 > 1$.
(A) $x > -3$ (B) $x < -3$ (C) $x > 4$ (D) $x > -4$
- Which value is NOT a solution of $3x - 2 \leq 10$?
(A) 4 (B) 0 (C) 5 (D) -3
- A bike rental costs 5 dollars plus 3 dollars per hour. Zoe can spend at most 20 dollars. Which inequality describes the number of hours h she can rent?
(A) $3h + 5 \geq 20$ (B) $3h + 5 < 20$ (C) $5h + 3 \leq 20$ (D) $3h + 5 \leq 20$
- Solve $3 - 4x \geq 15$.
(A) $x \geq -3$ (B) $x \leq -3$ (C) $x \leq 3$ (D) $x \geq 3$
- Which inequality describes all numbers that are at least -2 and less than 5 ?
(A) $-2 \leq x < 5$ (B) $-2 < x \leq 5$ (C) $-2 < x < 5$
(D) $x \geq -2$ or $x < 5$
- Which solution matches $2x + 1 < -5$ or $3x - 2 > 10$?
(A) $x < -3$ or $x < 4$ (B) $x > -3$ or $x > 4$ (C) $x < -3$ or $x > 4$
(D) $-3 < x < 4$
- Solve $7 - 3x > 22$.
- Solve $-4 \leq 3x - 1 < 11$.
- A cargo van can carry at most 800 pounds. It already holds 150 pounds of equipment. Each box weighs 35 pounds. What is the greatest whole number of boxes that can be added?
- Solve $5(2 - x) \geq 3x - 6$.
- Solve $4(x - 2) \leq 6x + 2$.
- A club needs to raise at least 500 dollars. It already has 120 dollars and sells candles for 4 dollars each. What is the fewest number of candles it must sell?

Answers and Explanations

Complete solutions for every practice problem, numbered to match. Read the explanation even when your answer is right.

05.1 Variables and Algebraic Expressions

PRACTICE · VARIABLES AND ALGEBRAIC EXPRESSIONS

- B. Substitute: $5(6) - 2 = 30 - 2 = 28$. Choice A comes from adding 2 instead of subtracting, and choice C comes from writing 5 and 6 side by side as 56.
- C. Like terms need the same letters with the same exponents. $7x^2y$ matches x^2y exactly. $4xy^2$ has the exponents on different letters, so it is not alike.
- D. Combine the a terms: $7a - 3a = 4a$. Combine the b terms: $2b + 5b = 7b$. Terms with different letters cannot merge, so $11ab$ is wrong.
- A. Multiply 5 by both terms: $5 \cdot 2x = 10x$ and $5 \cdot (-3) = -15$. Choice B only multiplies the first term.
- C. $x^2 = (-4)^2 = 16$ and $-3x = -3(-4) = 12$, so $16 + 12 = 28$. Choice B forgets that subtracting a negative adds, and choice A treats x^2 as -16 .
- B. Distribute: $6x + 12 - 3x + 12$. The second 12 comes from $-3 \cdot (-4) = +12$. Combine: $3x + 24$. Choice D forgets to distribute the -3 to the -4 correctly.
- D. Substitute: $3(5 + 2) - 5 = 21 - 5 = 16$. Choice B stops after $3(7) = 21$ and forgets to subtract a . Choice A distributes the 3 only to a .
- C. Distribute: $8y - 12$ and $-(y - 5) = -y + 5$. Combine: $8y - y = 7y$ and $-12 + 5 = -7$. So $7y - 7$. Choice A forgets that subtracting -5 gives $+5$.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

9. A. Distribute: $6x + 8 - 6x + 1$. The x terms cancel: $6x - 6x = 0$. The constants give $8 + 1 = 9$. Choice D forgets to subtract $6x$.
10. $11x + 13$. Distribute: $8x - 2 + 3x + 15$. Combine like terms: $11x + 13$.
11. 2. Substitute: $\frac{4^2 + 3(-2)}{5} = \frac{16 - 6}{5} = \frac{10}{5} = 2$.
12. Perimeter = $8x + 6$ cm, and it is 54 cm when $x = 6$. Perimeter is $2(\text{length}) + 2(\text{width}) = 2(3x + 4) + 2(x - 1) = 6x + 8 + 2x - 2 = 8x + 6$. Then $8(6) + 6 = 54$.
13. $-3x + 7$. Distribute: $-6x + 12$ for the first part. For the second part, $-(5 - x) = -5 + x$. So we have $-6x + 12 - 5 + x + 2x$. Combine x terms: $-6x + x + 2x = -3x$. Constants: $12 - 5 = 7$.
14. $2x + 13$. Distribute -2 : $-2x + 6$. Now $7 - 2x + 6 + 4x$. Combine: x terms $-2x + 4x = 2x$ and constants $7 + 6 = 13$.
15. Total is $4m + 16$, and it equals 40 when $m = 6$. Four boxes hold $4(m + 2)$ items. Add 3 muffins and 5 cookies: $4(m + 2) + 3 + 5 = 4m + 8 + 8 = 4m + 16$. With $m = 6$: $24 + 16 = 40$.

05.2 One-Step and Two-Step Equations

PRACTICE · ONE-STEP AND TWO-STEP EQUATIONS

1. C. Undo subtracting 7 by adding 7 to both sides: $x = 12 + 7 = 19$. Choice A subtracts instead of adding.
2. B. Undo multiplying by 6 by dividing both sides by 6: $n = 42 \div 6 = 7$. Choice D multiplies by 6 by mistake.
3. A. Undo dividing by 3 by multiplying both sides by 3: $m = 8 \cdot 3 = 24$. Choice C divides instead.
4. D. Subtract 9: $2x = 16$. Divide by 2: $x = 8$. Choice A adds 9 instead of subtracting, and choice C ignores the 9.
5. C. Add 8: $5x = 35$. Divide by 5: $x = 7$. Choice A subtracts 8 by mistake, giving $19 \div 5 = 3.8$.
6. B. Subtract 6: $\frac{x}{4} = -4$. Multiply by 4: $x = -16$. Choice D divides by 4 where it should multiply.
7. C. Add 5 to both sides: $14 = 2x$. Divide by 2: $x = 7$. Choice B (14) is only the middle step. Choice A subtracts 5 instead of adding it.
8. B. Add 3: $\frac{y}{5} = 2$. Multiply by 5: $y = 10$. Choice A subtracts 3 when it should add, giving -20 . Choice C stops before multiplying by 5.
9. A. The equation is $2.5m + 3 = 18$. Subtract 3: $2.5m = 15$. Divide by 2.5: $m = 6$. Choice D (15) forgets to divide by the 2.50 rate.
10. -4 . Subtract 4: $7x = -28$. Divide by 7: $x = -4$. Check: $7(-4) + 4 = -24$.
11. 3. Subtract 11: $-3x = -9$. Divide by -3 : $x = 3$. Check: $-9 + 11 = 2$.
12. 7 months. Let m be months: $12m + 25 = 109$. Subtract 25: $12m = 84$. Divide by 12: $m = 7$.
13. 18. Add 5: $\frac{2}{3}x = 12$. Multiply by $\frac{3}{2}$: $x = 12 \cdot \frac{3}{2} = 18$. Check: $12 - 5 = 7$.
14. -15 . Subtract 4: $-\frac{x}{5} = 5$. Multiply by -3 : $x = -15$. Check: $5 + 4 = 9$.
15. 10 minutes. Equation: $120 - 8t = 40$. Subtract 120: $-8t = -80$. Divide by -8 : $t = 10$. Check: $120 - 80 = 40$.

05.3 Multi-Step Equations

PRACTICE · MULTI-STEP EQUATIONS

1. D. Subtract $2x$: $2x + 3 = 11$. Subtract 3: $2x = 8$. So $x = 4$. Choice A adds $2x$ instead of subtracting it, giving $6x = 14$.
2. A. Distribute: $3x - 6 = 15$. Add 6: $3x = 21$. So $x = 7$. Choice C comes from forgetting the -2 inside the parentheses.
3. C. Distribute: $2x + 10 - 3 = x + 9$, so $2x + 7 = x + 9$. Subtract x : $x + 7 = 9$. So $x = 2$. Choice A forgets to distribute to the 5.
4. B. Multiply every term by 12: $4x + 3x = 168$, so $7x = 168$ and $x = 24$. Check: $8 + 6 = 14$. Choice C is the LCD, not the answer.
5. C. Multiply by 10: $6x - 15 = 2x + 5$. Subtract $2x$: $4x - 15 = 5$. Add 15: $4x = 20$, so $x = 5$. Choice A comes from using $0.8x$ instead of $0.4x$.
6. A. Subtract $4x$ from both sides of $4x + 1 = 4x + 7$: $1 = 7$, which is false, so no solution. Choice B gives $1 = 1$ (always true), and the others each give one solution.
7. B. Subtract $2x$ and subtract 6: $-5x = 15$. Divide by -5 : $x = -3$. Choice A has the right size but the wrong sign.
8. C. Multiply every term by 10: $5x - 2x = 30$, so $3x = 30$ and $x = 10$. Choice A is an earlier step, not the answer for x .
9. D. The constants already match. The equation is true for all x only when the x coefficients match, so $k = 4$. Choice A confuses the constant with the coefficient.
10. 7. Subtract $3x$: $2x - 4 = 10$. Add 4: $2x = 14$. So $x = 7$. Check: $31 = 31$.
11. 6. Distribute: $8x - 12 = 3x + 18$. Subtract $3x$: $5x - 12 = 18$. Add 12: $5x = 30$. So $x = 6$.
12. 4. Multiply every term by 6: $3x - 2 = x + 6$. Subtract x : $2x - 2 = 6$. Add 2: $2x = 8$, so $x = 4$. Check: $2 - \frac{1}{3} = \frac{5}{3}$ and $\frac{4}{6} + 1 = \frac{5}{3}$.
13. $k = -10$. Distribute: $5x - 10 = 5x + k$. Subtract $5x$: $-10 = k$. The equation is true for all x only when both sides match exactly, so $k = -10$.
14. 9. Distribute and combine: $6x - 13 = 4x + 5$. Subtract $4x$: $2x - 13 = 5$. Add 13: $2x = 18$. So $x = 9$.
15. 5. Multiply by 100: $25x + 50 = 75x - 200$. Subtract $25x$: $50 = 50x - 200$. Add 200: $250 = 50x$. So $x = 5$.

05.4 Inequalities and Their Graphs

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →

PRACTICE · INEQUALITIES AND THEIR GRAPHS

1. C. Add 3 to both sides: $x \geq 11$. Choice B subtracts 3 instead of adding it.
2. B. Divide both sides by 4 (positive, so no flip): $x < 7$. Choice A flips the sign when there was no reason to.
3. D. Divide both sides by -5 and reverse the sign: $x \geq -6$. Choice A forgets to reverse the sign.
4. A. Subtract 7: $2x > -6$. Divide by 2: $x > -3$. Choice C adds 7 instead of subtracting it.
5. C. Solving gives $3x \leq 12$, so $x \leq 4$. The value 5 is greater than 4, so it fails: $3(5) - 2 = 13 > 10$. The values 4, 0, and -3 all work.
6. D. "At most" means less than or equal, so use $\leq$. The cost is 3 dollars per hour times h plus the 5 dollar fee: $3h + 5 \leq 20$. Choice C swaps the 5 and the 3.
7. B. Subtract 3: $-4x \geq 12$. Divide by -4 and reverse the sign: $x \leq -3$. Choice A forgets to reverse the sign.
8. A. "At least -2 " includes -2 , so use $\leq$ on the left. "Less than 5" excludes 5, so use $<$ on the right. Choice B swaps the endpoints. Choice D uses "or", which would include every number.
9. C. The first part gives $2x < -6$, so $x < -3$. The second gives $3x > 12$, so $x > 4$. With "or" the graph has two pieces. Choice A shows $x < 4$ for the second part by reversing the sign by mistake, and choice D is the "and" answer.
10. $x < -5$. Subtract 7: $-3x > 15$. Divide by -3 and flip the sign: $x < -5$.
11. $-1 \leq x < 4$. Add 1 to all three parts: $-3 \leq 3x < 12$. Divide each part by 3: $-1 \leq x < 4$.
12. 18 boxes. The inequality is $35b + 150 \leq 800$. Subtract 150: $35b \leq 650$. Divide by 35: $b \leq 18.57$. Boxes are whole numbers, so the greatest is 18. Check: $35 \cdot 18 + 150 = 780 \leq 800$, but 19 boxes gives 815.
13. $x \leq 2$. Distribute: $10 - 5x \geq 3x - 6$. Add $5x$ and add 6: $16 \geq 8x$. Divide by 8: $2 \geq x$, which means $x \leq 2$.
14. $x \geq -5$. Distribute: $4x - 8 \leq 6x + 2$. Subtract $4x$: $-8 \leq 2x + 2$. Subtract 2: $-10 \leq 2x$. Divide by 2: $-5 \leq x$, which is $x \geq -5$.
15. 95 candles. The inequality is $4c + 120 \geq 500$. Subtract 120: $4c \geq 380$. Divide by 4: $c \geq 95$. Check: 95 candles give $380 + 120 = 500$; 94 candles give only 496.

Want a plan built around **your** student?

Book a free consultation. The short intake takes about a minute and opens right away.

BOOK NOW →