Balanced Moves to Solve for x

Teacher		**Class**	Grade 8
Subject	Math	**Topic**	Solving linear equations
Date		**Room**	
Lesson length	60 minutes	**Country**	United States

Students learn to solve linear equations in one variable. They practice in pairs with pencil and paper and check each answer.

Curriculum links

- Solve linear equations in one variable [2]
- Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and combining like terms [2]
- Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions by transforming into x = a, a = a, or a = b [2]

Learning objectives

- Students will solve two-step equations by undoing operations on both sides.
- Students will solve equations with distribution and variables on both sides.
- Students will identify one solution, no solution, or infinitely many solutions.

Success criteria

- I can undo addition and division on both sides to find x.
- I can distribute and move x-terms together to solve equations.
- I can tell if the result means one, none, or many answers.

What students already know

Show x + 5 = 11 and 4x = 20 on mini whiteboards. Ask what inverse undoes each and what x equals.

Key words

equation	a number sentence saying two sides have the same value [4]
variable	a letter that stands for a number we need to find [6]
inverse operations	an adding and subtracting pair, or multiplying and dividing pair, that undo each other [4]
like terms	parts with the same letter raised to the same power that can be combined [2]
solution	the number that makes both sides equal when plugged back in [8]

Materials

- Slides 1-2, 4-9, 11-12 with video clips
- printed Worksheet Task B sheets, pencils, timer
- mini whiteboards and markers
- multiplication chart and highlighters
- printed Worksheet Task C cards for stretch

Before the lesson

- Print Worksheet Task B for all pairs and Task C for stretch
- Test Slide 6 Video clip 1 (0:00–4:30) and Slide 8 Video clip 3 (0:00–4:40)
- Set timer for sprint, arrange desks for pairs, lay out whiteboards and highlighters

Lesson outline

0–7 min **Starter** 7 min · Whole class

Hook students and review keeping equations balanced and one-step solving.

YOU DO

1. Show Slide 1 and say the hook to set a focused, no-calculator mindset.
2. Show Slide 2 and ask: Both sides stay level. Take one thing off. What must you do?
3. Quick check: show x + 5 = 11 and 4x = 20 for all to solve on boards.
4. Link answers to goal: today we solve two-step and harder equations in one variable.

STUDENTS DO

1. Call out that both sides must get the same change to stay balanced.
2. Solve the two one-step equations on mini whiteboards and hold up.
3. Tell a partner which inverse operation they used and why.

Say: No phones, no calculators — just your brain against the clock. Ready? An equation is like a balance: do the same to both sides. If we take 2 off the left, we must take 2 off the right to stay level.

Ask: If the scale is balanced and you remove 2 from the left, what must you do? (Remove 2 from the right to keep both sides equal [4].) · How do you solve x + 5 = 11 and 4x = 20? (Subtract 5 to get x = 6; divide by 4 to get x = 5.)

Check understanding: Scan whiteboards for x = 6 and x = 5. If many miss, quickly model inverse operations again before moving on.

Support: Show an inverse reminder: adding pairs with subtracting, multiplying pairs with dividing. **Stretch:** Ask early finishers to write their own one-step equation with answer x = 9.

Use: Slides 1–2

7–20 min **Teaching: Two Steps to x** 13 min · Whole class

Model solving two-step equations by undoing addition then multiplication on both sides.

YOU DO

1. Show Slide 4 bullets and explain we isolate x by doing the same thing to both sides [4].
2. Model 3x + 2 = 14 step by step, thinking aloud about order.
3. Use Slide 5 for think, pair, share: If 3x + 2 = 14, what would you undo first? Why?
4. Play Video clip 1 (0:00–4:30) on Slide 6 and point out listening for keeping both sides balanced.

STUDENTS DO

1. Copy the two steps and underline what was done to both sides.
2. Discuss with a partner what to undo first in 3x + 2 = 14 and why.
3. Watch the video and note one line about staying balanced.

Say: A linear equation in one variable can be written in the form ax + b = c [6]. To find x, we undo in reverse. First undo the +2 with -2 on both sides, then undo times 3 with divide by 3. Then check by plugging back.

Worked example: Solve 3x + 2 = 14. Step 1: 3x + 2 - 2 = 14 - 2, so 3x = 12. Step 2: 3x / 3 = 12 / 3, so x = 4. Check: 3(4) + 2 = 12 + 2 = 14. Both sides equal.

Ask: In 3x + 2 = 14, why subtract 2 before dividing by 3? (Undo addition first to leave the x-term alone, then undo multiplication [4].) · How do you know x = 4 is correct? (Plug 4 back in: 3 times 4 plus 2 equals 14.)

Check understanding: Ask all to hold up boards showing first move for 2x + 3 = 11. Reteach order if split between moves.

Support: Give cards with the first step filled in, reminding to do the opposite operation on the other side [6]. **Stretch:** Ask what changes if the equation is 3x - 2 = 14 and how the check looks.

Use: Slides 4–6, Video clip 1 (0:00–4:30)

20–34 min **Teaching: x on Both Sides and Three Endings** 14 min · Whole class

Show distributing, moving x-terms together, and spotting one, none, or many answers.

YOU DO

1. Show Slide 7 cards: x = a means one solution, 5 = 6 means no solution, 4 = 4 means infinitely many.
2. Model 5x - 4 = 3x + 8 by moving x-terms to one side and numbers to the other.
3. Model 8x = 6 + 2(4x - 3) to show 0x = 0, and 3(2.5 - 2x) = 5 - 6x to show a false statement [8].
4. Play Video clip 3 (0:00–4:40) on Slide 8 and narrate moving x-terms and combining like terms after distributing.

STUDENTS DO

1. Copy both models and circle where terms moved sides and where distribution happened.
2. With a partner, say whether 0 = 0 or 7.5 = 5 means no solution or infinitely many.
3. Watch the video and list the order: distribute, combine, move x-terms, solve.

Say: When x is on both sides, get the x-terms together first. Simplify each side first, then combine like terms [4]. Keep going until you get x = a, a = a, or a = b where a and b are different numbers [2]. The ending tells you the number of answers.

Worked example: Solve 5x - 4 = 3x + 8. Subtract 3x both sides: 2x - 4 = 8. Add 4 both sides: 2x = 12. Divide by 2: x = 6. Check: 5(6)-4=26 and 3(6)+8=26. Example 2: 8x = 6 + 2(4x - 3) gives 8x = 6 + 8x - 6, so 0 = 0, always true, so every number works [8].

Ask: For 5x - 4 = 3x + 8, what is a good first move? (Subtract 3x from both sides to get x-terms together, then add 4 [2].) · What does 0 = 0 mean versus 7.5 = 5? (0 = 0 is always true so infinitely many; 7.5 = 5 is impossible so no solution [8].)

Check understanding: Vote with fingers: 1 for one solution, 0 for none, 5 for many for each ending. Re-model distributing if votes are split.

Support: Provide a worked example showing expanding with the distributive property and combining like terms before judging [2]. **Stretch:** Ask students to change one number to flip an equation from no solution to infinitely many solutions.

Use: Slides 7–8, Video clip 3 (0:00–4:40)

34–52 min **Main activity: Paper Power Sprint** 18 min · Pairs

Give paired pencil-and-paper practice solving varied equations and checking answers.

YOU DO

1. Show Slide 9 task and hand out Worksheet Task B sheets, pencils, and start timer.
2. Direct pairs to solve 2(x + 3) = 16, 5x - 4 = 3x + 8, x/2 + 5 = 11, and 3(2.5 - 2x) = 5 - 6x.
3. Remind them to simplify each side, combine terms, show each step, and check by plugging back.
4. Circulate, highlight x-terms for those stuck, and hand Task C fractions and special cases to fast pairs.

STUDENTS DO

1. Student A writes steps while Student B checks balance; switch roles each equation.
2. Solve, then plug the value back to show left equals right.
3. Swap papers with another pair to verify steps and checks.

Say: In pairs, solve 4 equations and check each answer by plugging back. No calculators, just pencil and paper. Show every step so a swap partner can see both sides stayed equal. You have timed sprints — pace yourselves.

Ask: For 2(x + 3) = 16, what do you do first? (Distribute to 2x + 6 = 16, then subtract 6 and divide by 2 to get x = 5 [6].) · For 5x - 4 = 3x + 8, how do you handle x on both sides? (Move x-terms together by subtracting 3x both sides, then solve to x = 6 [2].) · What do you do with x/2 + 5 = 11 that has a fraction? (Subtract 5 to get x/2 = 6, then multiply by 2 to get x = 12 [2].)

Check understanding: Collect one checked equation per pair and scan for equal-sides checks. Pull a small group if distribution or moving terms is off.

Support: Allow a multiplication chart and highlight the variable terms in one color to see what to move first. **Stretch:** Give (3/4)x + 1/2 = 2x - 5/2 and more rational-coefficient equations that need expanding and combining like terms.

Use: Slide 9, Worksheet Tasks B-C

52–60 min **Plenary** 8 min · Whole class

Confirm solving steps and solution types and set up the exit check.

YOU DO

1. Show Slide 11 and take a vote on favorite first move when x is on both sides.
2. Show Slide 12 true-or-false items and have pairs defend with transformed forms x = a, a = a, or a = b [2].
3. Model one quick correction: 3x + 5 = 3x + 9 leaves 5 = 9, impossible, so no solution.
4. Hand out exit ticket and preview homework.

STUDENTS DO

1. Vote and justify first move to a partner using one sentence starter.
2. Answer true-or-false on boards and explain the ending that proves it.
3. Complete the 3-question exit ticket on their own.

Say: Vote: move the smaller x-term first, move numbers first, or simplify and distribute first? There is no single favorite, but you must keep balance. Now prove true or false by showing your ending form.

Ask: Does 2(x + 3) = 14 solve to x = 4? (True, because distributing gives 2x + 6 = 14, so x = 4.) · Does 3x + 5 = 3x + 9 have no solution? (True, subtracting 3x leaves 5 = 9, impossible [2].)

Check understanding: Count true-or-false boards; if less than 80% correct, re-show the simplify-distribute-combine sequence tomorrow.

Support: Give sentence starters: It has ___ solution(s) because it simplifies to ___. **Stretch:** Ask students to write a new equation that simplifies to 4 = 4 and explain why it has many answers.

Use: Slides 11–12

Common mistakes

Mistake	How to spot it	How to fix it
Doing an operation to only one side of the equation	Steps show -2 on left but not right, or divide left only	Redo insisting on the same operation to both sides to keep balance and isolate x [4].
Distributing to only the first term, like 2(x + 3) becomes 2x + 3	Parentheses gone but +3 unchanged, answer too large	Multiply the outside number by each term inside, then collect like terms [6].
Mixing up 0 = 0 and 0 = 3 solution types	Student says 0x = 0 has no answer or 0x = -2.5 has many	Show 0x = 0 is always true so infinitely many, while 0x = -2.5 is impossible so no roots [8].

Support

- Allow a multiplication chart and highlight the variable terms in one color to see what to move first
- Give first-step cards and a worked distribution example with sentence starters

Stretch

- Add equations with rational number coefficients that need expanding and combining like terms
- Ask students to create and fix special-case equations and explain x = a, a = a, or a = b results

For the LSE or teaching assistant

Sit with sprint pairs needing reading or calculation support; prompt highlight x-terms, read Task B aloud, check each plug-back.

Check for understanding

Question	Answer
Solve: 2(x + 3) = 16	x = 5 because 2x + 6 = 16
Solve: 4x + 5 = 2x + 11	x = 3
How many solutions does 3x + 5 = 3x + 9 have? Why?	No solution because it simplifies to 5 = 9, which is impossible

Homework

Solve 4 equations from Worksheet Task C and check each by plugging back.

Sources

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