Find the Mystery Number

Teacher		**Class**	Year 9
Subject	Maths	**Topic**	Solving linear equations
Date		**Room**	
Lesson length	60 minutes	**Country**	United Kingdom

Students learn to rearrange and solve linear equations in one variable. They hunt matching solutions around the room and check each answer.

Curriculum links

- use algebraic methods to solve linear equations in 1 variable (including all forms that require rearrangement)

Learning objectives

- Students will solve one- and two-step linear equations using inverse operations to isolate x.
- Students will rearrange equations with x on both sides and brackets to find solution.
- Students will check solutions by substitution to keep both sides balanced and equal.

Success criteria

- I can undo + - x ÷ in correct order to isolate x.
- I can gather x terms together and expand brackets before solving.
- I can substitute my answer to check both sides are equal.

What students already know

Show x + 7 = 18 on mini whiteboards. Ask: What number plus 7 makes 18? What did you undo to find it?

Key words

equation	Two expressions equal, linked by =. [5]
variable	Letter standing for an unknown number. [5]
inverse operation	Opposite move that undoes a step. [5]
solution	Value that keeps both sides equal when put in. [10]

Materials

- Slides 1-7, 9-11
- Video clip 1 (0:00–4:40) ready on Slide 6
- equation cards taped around the room
- answer sheets
- mini whiteboards and pens
- Worksheet Task C printed for plenary

Before the lesson

- Print 8 equation cards and 8 matching answer cards, plus class sets of answer sheets.
- Print Worksheet Task C for plenary discussion.
- Test Slides 1-7, 9-11 and Video clip 1 (0:00–4:40) on Slide 6.
- Tape equation cards around the room with space around each, bags under tables and aisles clear.

Lesson outline

0–5 min **Starter** 5 min · Whole class

Hook pupils with the equation hunt and recall what balancing means.

YOU DO

1. Show Slide 1 and give the hook: Eight equations are hiding around the room. Find each one, solve it, then find its matching answer card.
2. Show Slide 2 and share that today is about rearranging to isolate x and checking by substitution.
3. Ask pairs to answer on whiteboards: x + 7 = 18, what is x and how do you know?
4. Take answers and link to scales that stay equal only if we do the same to both sides.

STUDENTS DO

1. Listen to the hunt challenge and read the objectives.
2. Solve x + 7 = 18 on whiteboards and show the check.
3. Explain to a partner why both sides must stay equal.

Say: Today we are number detectives. Eight equations are hiding around the room. You will find each one, solve it, then find its matching answer card. First, what does it mean to keep scales balanced?

Ask: What is x in x + 7 = 18, and what did you do to both sides? (x = 11, subtract 7 from both sides.) · What does this keep balanced, and how is it like an equation? (Doing the same to both sides keeps the scales and the equation balanced. [9])

Check understanding: Whiteboards up on x + 7 = 18. If many are unsure, remodel with cubes before moving on.

Support: Give a printed balance mat and start with positive whole numbers only. **Stretch:** Ask for x - 5 = 12 and explain which inverse undoes minus 5.

Use: Slides 1-2

5–17 min **Teaching** 12 min · Whole class

Revise linear form, inverse operations and checking by substitution.

YOU DO

1. Show Slides 3-4 and agree that a linear equation has x only as a multiple of x, not x squared or similar [4].
2. Show Slide 5 balance scales and model x + 7 = 18 by subtracting 7 from both sides [3].
3. Model 4z = 16 by dividing both sides by 4, naming division as the inverse of multiplication [5].
4. Model checking by substituting the answer into the original equation [5].

STUDENTS DO

1. Copy the balance rule and inverse pairs for +/-, x/divide.
2. Solve 4z = 16 on whiteboards and state the inverse used.
3. Practise substituting to check that both sides are the same [3].

Say: An equation shows two expressions are equal. To solve it we isolate the variable using the inverse operation. Whatever we do to one side, we must do to the other side, then we substitute back to check the balance.

Worked example: Solve x + 7 = 18. Step 1: subtract 7 from both sides, because equations are solved by adding or subtracting the same quantity to or from both sides [3]. x = 18 - 7. Step 2: x = 11. Check: substitute 11 in place of x to make 18 [5], because 11 + 7 = 18.

Ask: Why must we subtract 7 from both sides, not just the left? (To maintain equality between two statements [9]; otherwise the scales tip.) · What is the inverse that undoes x ÷ 12 = 3? (Multiply by 12, giving x = 36, because the inverse of dividing by 12 is multiplying by 12. [12])

Check understanding: Hinge on whiteboards: 4z = 16. Expect z = 4. Reteach dividing both sides if needed.

Support: Show the step prompt: subtract or add first with positives, with worked example 5x + 11 = 22 [3]. **Stretch:** Add negatives such as 5x - 2 = -12 and ask for the first inverse move.

Use: Slides 3-5

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17–30 min **Modelling** 13 min · Whole class

Model the four-move method for two-step, both sides and brackets equations.

YOU DO

1. Play Video clip 1 (0:00–4:40) on Slide 6. Pupils spot each inverse and note add and subtract before multiply and divide.
2. Show Slide 7 steps: expand and collect, gather x terms one side, undo + and - then x and ÷, check by substituting back in.
3. Live-model 5x + 11 = 22 by subtracting 11 then dividing by 5 [3].
4. Live-model 3(x + 4) = 27 by expanding to 3x + 12 = 27, then solving to x = 5.

STUDENTS DO

1. Watch and list the inverse operations used in the video.
2. Copy the 4 moves and the worked 5x + 11 = 22 steps.
3. Try 3x + 8 = 15 on whiteboards as the video models.

Say: Most equations need tidying before solving. Expand brackets and collect like terms so the equation is ready to be solved [9]. Then gather x together, undo plus and minus before multiply and divide, and check by substitution.

Worked example: Solve 13x - 2 = 11x + 17. Step 1: subtract 11x from both sides to get 2x - 2 = 17 [3]. Step 2: add 2 to both sides to get 2x = 19. Step 3: divide both sides by 2 to get x = 19/2. Check by substituting 19/2 so both sides are the same [3].

Ask: In 5x + 11 = 22, why subtract 11 before dividing by 5? (Isolate the variable by undoing addition or subtraction before multiplication or division [5].) · Why expand 3(x + 4) before anything else? (To appreciate the significance of the bracket in an equation [9] and get it ready to solve.)

Check understanding: Whiteboards for 3x + 8 = 15. Expect x = 7/3. Correct order errors immediately.

Support: Give expansion reminder and first step done, with like terms highlighted in the same colour. **Stretch:** Ask pupils to explain 4(2m - 5) = 3(m + 5) first move without fully solving.

Use: Slides 6-7, Video clip 1 (0:00–4:40)

30–50 min **Main activity** 20 min · Pairs

Practise solving equations with unknowns on both sides to find matching solutions.

YOU DO

1. Show Slides 9-10 and explain the hunt: walk only, solve, record the two moves, then find the matching answer card.
2. Point out 8 cards such as 5x + 12 = 3x + 20 and 11x - 12 = 6x + 18, plus stretch card 7c - 22 = 10 - c.
3. Remind pairs to move variable terms to one side so the unknowns are on one side and then solve [9], by subtracting the smaller x-term from both sides.
4. Stop at 15 minutes for pairs to compare methods and substitution checks.

STUDENTS DO

1. Walk in pairs to equation cards, solve by gathering x on one side then isolating.
2. Record the two moves and final value on answer sheets.
3. Match to answer cards and check by substituting the answer into the original equation [5].

Say: You have 15 minutes to hunt. Walk to a card, gather the x terms together first, then numbers, then divide. Write both moves and the final value. Then find its answer card and check by substituting back. Walk only and leave space around each card.

Ask: What first move gathers x together in 5x + 12 = 3x + 20? (Subtract 3x from both sides, leaving 2x + 12 = 20, then solve to x = 4.) · How do you know your solution is correct? (Substitute it so both sides are the same [3]; the two sides balance [9].)

Check understanding: Circulate with answer sheet; check recorded moves and substitution. Pair cards with same solution to self-check [9].

Support: Colour-code the x-terms and number terms so pupils can see what to collect on each side before isolating [9]. **Stretch:** Include cards where the solution check needs substitution with negatives, such as 7c - 22 = 10 - c.

Use: Slides 9-10

50–60 min **Plenary** 10 min · Whole class

Fix the common order error and prove all equation types can be solved.

YOU DO

1. Show Slide 11: A student solves 5x + 11 = 22 as x = 33/5. What went wrong and what is x?
2. Use Worksheet Task C: pupils find the first wrong step and explain the fix.
3. Take votes and model the correct fix: subtract 11 to get 5x = 11, so x = 11/5.
4. Return to objectives and set homework.

STUDENTS DO

1. Vote for the error and explain in one sentence how it breaks equality.
2. Correct the solution on whiteboards and show the substitution check.
3. Self-assess against the three success criteria.

Say: Only one method keeps the balance. The error added 11 instead of subtracting. We undo plus 11 by subtracting 11 from both sides, giving 5x equals 11. So x equals 11 over 5. Always substitute to prove it.

Worked example: Fix 5x + 11 = 22. Wrong step added 11 to get 33. Correct: subtract 11 from both sides to get 5x = 11 [3], divide by 5 to get x = 11/5. Check: 5 x 11/5 + 11 = 11 + 11 = 22.

Ask: What went wrong to get x = 33/5? (They added 11 instead of using the inverse, subtract 11; correct x = 11/5.) · In 5x + 11 = 22, what proves 11/5 is right? (Substituting 11/5 makes both sides 22, so the solution makes both sides the same [3].)

Check understanding: Whiteboard exit: solve 2x + 5 = 13. Expect x = 4. Re-explain inverse order if needed.

Support: Give sentence starters such as They forgot to... and highlight the balance check [9]. **Stretch:** Ask pupils to invent a plausible wrong step and explain what rule it breaks.

Use: Slide 11, Worksheet Task C

Common mistakes

Mistake	How to spot it	How to fix it
Doing an operation to one side only	Left and right values no longer match when checked	Insist on doing the same to both sides to maintain equality [9]; re-do with balance mat.
Dividing before undoing + or - in two-step equations	Answer like x = 33/5 for 5x + 11 = 22	Undo addition or subtraction before multiplication or division [5]; subtract 11 first to get 5x = 11.
Not expanding brackets or not collecting like terms first	Bracket still present at divide step, or 2y + 5y left uncombined	Expand, then simplify by collecting terms together [5] so the equation is ready to be solved [9].

Support

- Colour-code the x-terms and number terms so pupils can see what to collect on each side before isolating [9].
- Provide balance mat, step prompt card and worked example of 5x + 11 = 22 [3].
- Provide equation skeleton with blanks to link stories to algebra.

Stretch

- Include cards where the solution check needs substitution with negatives, such as 7c - 22 = 10 - c.
- Try 4(2m - 5) = 3(m + 5) and (5x - 27) ÷ 2 = x.
- Ask pupils to write their own two-step problem and mark a partner's method.

For the LSE or teaching assistant

Stay with the hunt group needing support: point to colour-coded x-terms, prompt subtract smaller x-term first, then check by substitution together.

Safety

- Walk only, keep bags under tables and aisles clear, and leave space around each card.

Check for understanding

Question	Answer
Solve 2x + 5 = 13	x = 4
Solve 5x - 3 = 2x + 9	x = 4
Solve 3(x + 4) = 27	x = 5

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Homework

Complete Worksheet Task D: solve equations with x on both sides and brackets, showing each move.

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