

TEACHER AND STUDENT RESOURCE

Justifying Equation-Solving Steps



NC Math 1 • NC.M1.A-REI.1

Equations, inequalities and mathematical reasoning

Seven instructional sections with 30 multiple-choice and 30 open or performance tasks, teaching scripts, original mathematical visuals, generous workspaces, and worked keys.

Free sample | Contents

NC.M1.A-REI.1 | NC Math 1 mathematics

This sample contains 19 complete selected pages from the 92-page resource, plus this sample contents page. Original printed page numbers are retained. Gaps are intentional.

Included original pages: 1-15, 30-31, 60, 75

Representative activities

M01: sample PDF page(s) 16; original page(s) 15

M02: sample PDF page(s) 16; original page(s) 15

O01: sample PDF page(s) 17; original page(s) 30

O02: sample PDF page(s) 18; original page(s) 31

Selected teacher prompts and keys: original page(s) 60, 75

Using this sample

Read the preparation and access guidance before using a selected activity.

Keep teacher keys and private preparation pages separate from student copies.

Use the original resource contents to see the scope of the complete packet.

Complete paid download

The complete resource includes the full PDF task bank and teaching materials.

ALIGNMENT

Standard and learning targets

Justify a chosen solution method and each step of the solving process for linear and quadratic equations using mathematical reasoning.

T1 Explain reversible steps in linear equations.

T2 Justify quadratic methods and every solution branch.

T3 Evaluate equivalence, restrictions and solution checks.

Each item names its own target. The bank supports multiple sessions; do not assign all 60 tasks in one sitting.

NAVIGATION

Choose evidence deliberately

Warm-up: M01-M04 and O01-O04

I Do: M05-M08 and O05-O08

We Do: M09-M13 and O09-O13

Collaborative practice: M14-M18 and O14-O18

Independent practice: M19-M23 and O19-O23

Small-group reteach: M24-M27 and O24-O27

Exit ticket: M28-M30 and O28-O30

T1: M01, O01, M02, O02, M07, O07, M11, O11, M12, O12, M17, O17, M21, O21, M22, O22, M27, O27

T2: M03, O03, M04, O04, M06, O06, M10, O10, M13, O13, M14, O14, M16, O16, M20, O20, M23, O23, M24, O24, M26, O26, M30, O30

T3: M05, O05, M08, O08, M09, O09, M15, O15, M18, O18, M19, O19, M25, O25, M28, O28, M29, O29

PLANNING

Materials, access and pacing

Materials

Pencils, erasers, straightedge, student pages, and optional graph paper. A calculator may support arithmetic after a learner states the intended relationship. No device or paid software is required.

Prerequisites

Signed-number arithmetic, distributive property, substitution, products and square roots. Diagnose these separately before scoring the targeted reasoning.

Pacing

Use a short diagnostic warm-up, a model and shared task in one session; collaborative and independent reasoning in later sessions; then targeted reteaching and an exit task. Select two to four tasks at a time based on evidence. Each section's full bank is reusable, not mandatory in one lesson.

Neutral access

Read directions aloud without interpreting the graph, enlarge a page, supply a writing or pointing response method, and allow a learner to dictate an explanation. Keep axes, units, data and mathematical demand unchanged.

Separate instruction from evidence

Keep the learner's first response. Record answer-supplying cues separately from access supports. A completed teacher graph or worked key is for discussion after independent work, never a student construction template.

Review convention

An equivalent equation has exactly the same solution set. State nonzero divisors and check candidates after any non-reversible step. Linear and quadratic equations are the assessed scope; no rational-equation method is assumed.

TEACHER MODEL

Forward truth is not enough

A learner changes $x = 4$ to $x^2 = 16$ and reports two solutions. Is the replacement equivalent?

The original solution 4 satisfies the squared equation, so the forward implication holds. But -4 also satisfies $x^2=16$ and fails $x=4$. Thus the reverse implication fails and the equations are not equivalent. Check both candidates in the original: only 4 remains. Contrast adding 3 to both sides, $x+3=7$; subtraction reverses that operation and proves equivalence.

VISUAL ANCHOR

Track the complete solution set

Start

$$3x + 6 = 18$$

↓ Subtract 6 from BOTH sides.

Result

$$3x = 12$$

Start

$$3x = 12$$

↓ Divide BOTH sides by nonzero 3.

Result

$$x = 4$$

Read upward to reverse: multiply by 3, then add 6. Both directions work.

Compare $x = 4 \rightarrow x^2 = 16$: the reverse fails at $x = -4$.

A forward arrow alone does not prove equal solution sets.

REUSABLE REASONING GUIDE

Represent, justify, interpret

Name: _____ Date: _____

Givens, quantities and restrictions**Representation and calculation****Justification or check****Conclusion, domain and units**

WARM-UP

Teaching script

Core: 001 • T1: Explain reversible steps in linear equations.

Optional bank: M01–M04; O01–O04. Select tasks across more than one meeting if needed.

Suggested discussion/work time: 5–8 minutes. Adjust for access and evidence; this is not a speed criterion.

Display student page O01, including its graph when present. Invite a first independent response before discussion. Ask, “What do the symbols represent? What evidence supports your claim?”

Core task

Solve $2x - 5 = 1$. Justify each step with a property and explain how to reverse it.

Teacher solution and discussion

Add 5 to both sides: $2x=6$; reverse by subtraction. Divide both sides by nonzero 2: $x=3$; reverse by multiplication. Each step is reversible, so the solution set is preserved. Substitution gives 1 on both sides.

Evidence and response

Look for a claim tied to specific terms, factors, operations or graph features. If a learner only names an answer, ask which values or parts of the graph support it. If a sign or operation is mishandled, reconstruct that step with a numerical analogy, then collect a fresh response. A selected option alone does not identify a unique misconception.

Closure: Ask learners to state one feature they verified and one check they used. Use the worked key for M01 to compare all alternatives after evidence is collected.

I DO

Teaching script

Core: 005 • T3: Evaluate equivalence, restrictions and solution checks.

Optional bank: M05–M08; O05–O08. Select tasks across more than one meeting if needed.

Suggested discussion/work time: 10–12 minutes. Adjust for access and evidence; this is not a speed criterion.

Display student page O05, including its graph when present. Think aloud through the core task. Say, “I will identify the quantities first, then build a representation and check it against the stated domain.” Hide the worked key until after predictions.

Core task

A learner solves $x = 3$ by squaring and reports $x = \pm 3$. Explain the implication failure and check the candidates.

Teacher solution and discussion

Every solution of $x=3$ solves $x^2=9$, but not conversely. The positive candidate 3 satisfies the original; -3 does not. The original solution set is only $\{3\}$. Checking original equations removes candidates introduced by a non-equivalent step.

Evidence and response

Look for a claim tied to specific terms, factors, operations or graph features. If a learner only names an answer, ask which values or parts of the graph support it. If a sign or operation is mishandled, reconstruct that step with a numerical analogy, then collect a fresh response. A selected option alone does not identify a unique misconception.

Closure: Ask learners to state one feature they verified and one check they used. Use the worked key for M05 to compare all alternatives after evidence is collected.

WE DO

Teaching script

Core: 009 • T3: Evaluate equivalence, restrictions and solution checks.

Optional bank: M09–M13; O09–O13. Select tasks across more than one meeting if needed.

Suggested discussion/work time: 10–15 minutes. Adjust for access and evidence; this is not a speed criterion.

Display student page O09, including its graph when present. Have learners propose the next step, then ask a partner to verify it using the original representation. Record more than one valid explanation.

Core task

For $x = -3$, compare multiplying both sides by 0 with multiplying by 2. Prove which replacement preserves the solution set.

Teacher solution and discussion

Zero multiplication gives $0=0$, satisfied by every real x , so it loses information. Multiplication by nonzero 2 gives $2x=-6$, which can be divided by 2 to recover $x=-3$. This proves both directions only for the nonzero multiplier.

Evidence and response

Look for a claim tied to specific terms, factors, operations or graph features. If a learner only names an answer, ask which values or parts of the graph support it. If a sign or operation is mishandled, reconstruct that step with a numerical analogy, then collect a fresh response. A selected option alone does not identify a unique misconception.

Closure: Ask learners to state one feature they verified and one check they used. Use the worked key for M09 to compare all alternatives after evidence is collected.

COLLABORATIVE PRACTICE

Teaching script

Core: O14 • T2: Justify quadratic methods and every solution branch.

Optional bank: M14–M18; O14–O18. Select tasks across more than one meeting if needed.

Suggested discussion/work time: 15–20 minutes. Adjust for access and evidence; this is not a speed criterion.

Display student page O14, including its graph when present. Assign reader, representer, checker and explainer roles. Each learner first makes a private prediction; compare reasoning and resolve differences with the data.

Core task

Solve $(x + 3)^2 = 16$. Explain the meaning of $\sqrt{16}$ and why $\pm$ appears in your solution.

Teacher solution and discussion

$\sqrt{16}=4$, the principal nonnegative root. But $x+3$ may equal 4 or -4; therefore $x=1$ or -7. Both produce the same square. Taking only the principal branch of $x+3$ would lose a solution.

Evidence and response

Look for a claim tied to specific terms, factors, operations or graph features. If a learner only names an answer, ask which values or parts of the graph support it. If a sign or operation is mishandled, reconstruct that step with a numerical analogy, then collect a fresh response. A selected option alone does not identify a unique misconception.

Closure: Ask learners to state one feature they verified and one check they used. Use the worked key for M14 to compare all alternatives after evidence is collected.

INDEPENDENT PRACTICE

Teaching script

Core: O19 • T3: Evaluate equivalence, restrictions and solution checks.

Optional bank: M19–M23; O19–O23. Select tasks across more than one meeting if needed.

Suggested discussion/work time: 15–20 minutes. Adjust for access and evidence; this is not a speed criterion.

Display student page O19, including its graph when present. Provide the printed task and neutral access supports. Preserve the first independent response; do not point to the requested answer or select a method for the learner.

Core task

For $x = -4$, compare multiplying both sides by 0 with multiplying by 3. Prove which replacement preserves the solution set.

Teacher solution and discussion

Zero multiplication gives $0=0$, satisfied by every real x , so it loses information. Multiplication by nonzero 3 gives $3x=-12$, which can be divided by 3 to recover $x=-4$. This proves both directions only for the nonzero multiplier.

Evidence and response

Look for a claim tied to specific terms, factors, operations or graph features. If a learner only names an answer, ask which values or parts of the graph support it. If a sign or operation is mishandled, reconstruct that step with a numerical analogy, then collect a fresh response. A selected option alone does not identify a unique misconception.

Closure: Ask learners to state one feature they verified and one check they used. Use the worked key for M19 to compare all alternatives after evidence is collected.

SMALL-GROUP RETEACH

Teaching script

Core: O24 • T2: Justify quadratic methods and every solution branch.

Optional bank: M24–M27; O24–O27. Select tasks across more than one meeting if needed.

Suggested discussion/work time: 10–15 minutes. Adjust for access and evidence; this is not a speed criterion.

Display student page O24, including its graph when present. Start with the learner's prior evidence. Rebuild one representation with explicit terms and operations, then use a fresh item to check transfer without the prior cue.

Core task

Solve $(x + 4)^2 = 25$. Explain the meaning of $\sqrt{25}$ and why $\pm$ appears in your solution.

Teacher solution and discussion

$\sqrt{25}=5$, the principal nonnegative root. But $x+4$ may equal 5 or -5; therefore $x=1$ or -9. Both produce the same square. Taking only the principal branch of $x+4$ would lose a solution.

Evidence and response

Look for a claim tied to specific terms, factors, operations or graph features. If a learner only names an answer, ask which values or parts of the graph support it. If a sign or operation is mishandled, reconstruct that step with a numerical analogy, then collect a fresh response. A selected option alone does not identify a unique misconception.

Closure: Ask learners to state one feature they verified and one check they used. Use the worked key for M24 to compare all alternatives after evidence is collected.

EXIT TICKET

Teaching script

Core: O28 • T3: Evaluate equivalence, restrictions and solution checks.

Optional bank: M28–M30; O28–O30. Select tasks across more than one meeting if needed.

Suggested discussion/work time: 5–8 minutes. Adjust for access and evidence; this is not a speed criterion.

Display student page O28, including its graph when present. Ask for a concise claim supported by the representation. Collect the response before sharing a solution; use it to choose the next instructional step.

Core task

Explain the different solution sets of $4x+5=4x+5$ and $4x+5=4x+6$. Use valid subtraction steps.

Teacher solution and discussion

First subtract $4x+5$: $0=0$, so all real x work. In the second the same subtraction gives $0=1$, so no real x works. Variable cancellation alone does not determine the conclusion; the remaining statement does.

Evidence and response

Look for a claim tied to specific terms, factors, operations or graph features. If a learner only names an answer, ask which values or parts of the graph support it. If a sign or operation is mishandled, reconstruct that step with a numerical analogy, then collect a fresh response. A selected option alone does not identify a unique misconception.

Closure: Ask learners to state one feature they verified and one check they used. Use the worked key for M28 to compare all alternatives after evidence is collected.

MULTIPLE-CHOICE BANK

M01 / M02 • Select and justify**M01 | Warm-up | T1****Which operation justifies $2x + 5 = 11$ becoming $2x = 6$?**

- A. Divide both sides by 5.
- B. Add 5 to both sides.
- C. Subtract 5 from the left only.
- D. Subtract 5 from both sides.

Reasoning: _____

M02 | Warm-up | T1**What justifies rewriting $2(x + 5) = 6$ as $2x + 10 = 6$?**

- A. Division by the variable
- B. Adding the constant to both sides
- C. The distributive property
- D. The zero-product property

Reasoning: _____

WARM-UP

001 • Show your reasoning**T1: Explain reversible steps in linear equations.****Solve $2x - 5 = 1$. Justify each step with a property and explain how to reverse it.****Representation / calculation****Explanation / check**

WARM-UP

002 • Show your reasoning**T1: Explain reversible steps in linear equations.****Solve $2(x + 3) = 10$. Label distribution, subtraction and division steps, then explain an alternative order.****Representation / calculation****Explanation / check**

WORKED TEACHER KEYS

M01 / M02**M01 • T1: Explain reversible steps in linear equations.****Answer: D. Subtract 5 from both sides.**

Subtracting the same 5 from equal quantities preserves equality and is reversed by adding 5.

Check each alternative

- A. Division scales every term and does not remove the added constant.
- B. Addition gives $2x+10=16$.
- C. Changing only one side does not preserve equality.
- D. Subtracting the same 5 from equal quantities preserves equality and is reversed by adding 5.

M02 • T1: Explain reversible steps in linear equations.**Answer: C. The distributive property**

$2(x+5)=2x+10$ for every real x , so an identical expression replaces the left side.

Check each alternative

- A. No division occurs in this rewrite.
- B. The right side is unchanged; this is rewriting one expression.
- C. $2(x+5)=2x+10$ for every real x , so an identical expression replaces the left side.
- D. Zero-product reasoning requires a product equal to zero.

WORKED TEACHER KEYS

001 / 002**001 • T1: Explain reversible steps in linear equations.**

Add 5 to both sides: $2x=6$; reverse by subtraction. Divide both sides by nonzero 2: $x=3$; reverse by multiplication. Each step is reversible, so the solution set is preserved. Substitution gives 1 on both sides.

002 • T1: Explain reversible steps in linear equations.

Distribute: $2x+6=10$. Subtract 6: $2x=4$. Divide by 2: $x=2$. Alternatively divide first to get $x+3=5$, then subtract 3. Both use reversible operations and yield the same solution.