

TEACHER AND STUDENT RESOURCE

Function Composition



NC Math 4 • NC.M4.AF.1

Advanced Mathematics

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.M4.AF.1 | NC Math 4 mathematics

This sample contains 19 complete selected pages from the 96-page resource, plus this sample contents page. Original printed page numbers are retained. Gaps are intentional.

Included original pages: 1-15, 32-33, 62, 77

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) 32

O02: sample PDF page(s) 18; original page(s) 33

Selected teacher prompts and keys: original page(s) 62, 77

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

Apply properties of function composition to build new functions from existing functions.

T1 NC.M4.AF.1.1 Compose two functions algebraically and preserve the order.

T2 NC.M4.AF.1.2 Evaluate compositions from formulas, tables and graphs.

NC.M4.AF.1.1 Execute algebraic procedures to compose two functions.

NC.M4.AF.1.2 Execute a procedure to determine the value of a composite function at a given value when the functions are in algebraic, graphical, or tabular representations.

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: M02, M04, M05, M07, M09, M11, M13, M15, M17, M19, M21, M23, M25, M27, M29, O02, O04, O05, O07, O09, O11, O13, O15, O17, O19, O21, O23, O25, O27, O29

T2: M01, M03, M06, M08, M10, M12, M14, M16, M18, M20, M22, M24, M26, M28, M30, O01, O03, O06, O08, O10, O12, O14, O16, O18, O20, O22, O24, O26, O28, O30

DAILY LEARNING TARGETS

A multi-session teaching path

Session 1 Diagnose and model

Learning target: NC.M4.AF.1.1 Compose two functions algebraically and preserve the order.

Learning target: NC.M4.AF.1.2 Evaluate compositions from formulas, tables and graphs.

Use warm-up evidence to choose explicit I Do models. Collect predictions before revealing the worked solution.

Session 2 Compare and explain

Learning target: NC.M4.AF.1.2 Evaluate compositions from formulas, tables and graphs.

Use selected We Do and collaborative tasks. Ask each learner for an initial representation, then compare methods and checks.

Session 3 Transfer independently

Learning target: Apply the objectives with explicit restrictions, checks and contextual interpretations.

Choose independent items across every objective. Use small-group tasks for a documented gap and a fresh exit task to test transfer.

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

Function notation, substitution, basic polynomial operations, and reading a point from a graph.

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

$(f \circ g)(x) = f(g(x))$: evaluate the inner function first. Tables and isolated graph points contain only the stated inputs unless a continuous rule is specified. Composition is not multiplication. Square roots mean the nonnegative real root; a valid input must survive both stages.

TEACHER MODEL

Follow the output into the next input

Let $f(x)=x^2+1$ and $g(x)=2x-3$. Find $f(g(x))$ and evaluate the composition at $x=4$.

Substitute the entire inner expression: $f(g(x))=(2x-3)^2+1=4x^2-12x+10$. At $x=4$, $g(4)=5$ and $f(5)=26$. The expanded rule also gives $64-48+10=26$. Reversing order gives $g(f(x))=2x^2-1$, a different function.

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 • T2: NC.M4.AF.1.2 Evaluate compositions from formulas, tables and graphs.

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

Let $f(x)=3x-2$ and $g(x)=x^2+1$. Evaluate $f(g(-2))$ by showing both stages. Then evaluate $g(f(-2))$ and compare.

Teacher solution and discussion

$g(-2)=5$, so $f(g(-2))=13$. $f(-2)=-8$, so $g(f(-2))=65$. The different values show that reversing composition can change the result.

Evidence and response

Ask learners to name the intermediate output, then locate it as an input to the outer function. Diagnose reversed order separately from arithmetic errors. On a table or graph trace input → inner output → outer output; a missing outer input makes that evaluation undefined.

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 • T1: NC.M4.AF.1.1 Compose two functions algebraically and preserve the order.

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

Compose $f(x)=x^2-2x+1$ with $g(x)=x+3$. Show substitution before expansion, then check the constant term using $x=0$.

Teacher solution and discussion

$f(g(x))=(x+3)^2-2(x+3)+1=x^2+4x+4$. At $x=0$, $g(0)=3$ and $f(3)=4$, agreeing with the constant term.

Evidence and response

Ask learners to name the intermediate output, then locate it as an input to the outer function. Diagnose reversed order separately from arithmetic errors. On a table or graph trace input → inner output → outer output; a missing outer input makes that evaluation undefined.

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 • T1: NC.M4.AF.1.1 Compose two functions algebraically and preserve the order.

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

Compare $f(g(x))$ and $g(f(x))$ for $f(x)=\sqrt{x}$ and $g(x)=x^2$. State real domains and test $x=-4$ where appropriate.

Teacher solution and discussion

$f(g(x))=\sqrt{(x^2)}=|x|$ for all real x , so its value at -4 is 4 . $g(f(x))=(\sqrt{x})^2=x$ only for $x\geq 0$; the inner root is not real at -4 . Equal-looking simplifications cannot remove the original domain restriction.

Evidence and response

Ask learners to name the intermediate output, then locate it as an input to the outer function. Diagnose reversed order separately from arithmetic errors. On a table or graph trace input $\rightarrow$ inner output $\rightarrow$ outer output; a missing outer input makes that evaluation undefined.

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: NC.M4.AF.1.2 Evaluate compositions from formulas, tables and graphs.

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

A reservoir's volume is $V(t)=120-6t$ liters for $0 \leq t \leq 20$ minutes. A display converts liters to gallons by $G(v)=v/3.785$. Evaluate $G(V(5))$ to the nearest hundredth and interpret the intermediate and final units.

Teacher solution and discussion

$V(5)=90$ liters. $G(90)=90/3.785 \approx 23.78$ gallons. The inner function takes minutes to liters; the outer takes liters to gallons, so the composition takes minutes to gallons.

Evidence and response

Ask learners to name the intermediate output, then locate it as an input to the outer function. Diagnose reversed order separately from arithmetic errors. On a table or graph trace input $\rightarrow$ inner output $\rightarrow$ outer output; a missing outer input makes that evaluation undefined.

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 • T1: NC.M4.AF.1.1 Compose two functions algebraically and preserve the order.

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 $f(x)=x^2$ and $g(x)=2x+1$, find all real x for which the two composition orders agree. Verify each solution.

Teacher solution and discussion

$f(g(x))=(2x+1)^2=4x^2+4x+1$; $g(f(x))=2x^2+1$. Equality gives $2x^2+4x=2x(x+2)=0$, so $x=0$ or -2 . At 0 both give 1; at -2 both give 9.

Evidence and response

Ask learners to name the intermediate output, then locate it as an input to the outer function. Diagnose reversed order separately from arithmetic errors. On a table or graph trace input $\rightarrow$ inner output $\rightarrow$ outer output; a missing outer input makes that evaluation undefined.

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: NC.M4.AF.1.2 Evaluate compositions from formulas, tables and graphs.

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

For $f(x)=x/2$ and $g(x)=x+6$, show how to evaluate $g(f(10))$ using a two-machine diagram. Explain the wrong-order value and how to distinguish the two.

Teacher solution and discussion

Correct order: $10 \rightarrow f \rightarrow 5 \rightarrow g \rightarrow 11$. Reversed: $10 \rightarrow g \rightarrow 16 \rightarrow f \rightarrow 8$. The function nearest the original input is evaluated first.

Evidence and response

Ask learners to name the intermediate output, then locate it as an input to the outer function. Diagnose reversed order separately from arithmetic errors. On a table or graph trace input $\rightarrow$ inner output $\rightarrow$ outer output; a missing outer input makes that evaluation undefined.

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 • T2: NC.M4.AF.1.2 Evaluate compositions from formulas, tables and graphs.

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

From $f(1)=3$, $f(3)=2$, $g(2)=4$, and $g(4)=1$, evaluate $g(f(3))$. State one additional function value needed to evaluate $f(g(2))$.

Teacher solution and discussion

$g(f(3))=g(2)=4$. For $f(g(2))$, $g(2)=4$, so the missing value is $f(4)$. No other given value determines it without an additional rule.

Evidence and response

Ask learners to name the intermediate output, then locate it as an input to the outer function. Diagnose reversed order separately from arithmetic errors. On a table or graph trace input → inner output → outer output; a missing outer input makes that evaluation undefined.

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 | T2****If $f(x)=2x+1$ and $g(x)=x^2$, what is $f(g(3))$?**

- A. 49
- B. 19
- C. 21
- D. 9

Reasoning: _____

M02 | Warm-up | T1**For $f(x)=x-4$ and $g(x)=3x$, which is $(f \circ g)(x)$?**

- A. $3x-4$
- B. $3x-12$
- C. $3x^2-12x$
- D. $4x-4$

Reasoning: _____

WARM-UP

001 • Show your reasoning

T2: NC.M4.AF.1.2 Evaluate compositions from formulas, tables and graphs.

Let $f(x)=3x-2$ and $g(x)=x^2+1$. Evaluate $f(g(-2))$ by showing both stages. Then evaluate $g(f(-2))$ and compare.

Representation / calculation

Explanation / check

WARM-UP

002 • Show your reasoning

T1: NC.M4.AF.1.1 Compose two functions algebraically and preserve the order.

For $f(x)=4-x$ and $g(x)=2x+3$, find $f \circ g$ and $g \circ f$ algebraically. Verify both formulas at $x=1$.

Representation / calculation

Explanation / check

WORKED TEACHER KEYS

M01 / M02**M01 • T2: NC.M4.AF.1.2 Evaluate compositions from formulas, tables and graphs.****Answer: B. 19** $g(3)=9$, then $f(9)=2\cdot 9+1=19$.**Check each alternative**

- A. This is $g(f(3))$, the reverse order.
- B. Correct. $g(3)=9$, then $f(9)=2\cdot 9+1=19$.
- C. This multiplies neither correct stage; $g(3)=9$, then $f(9)=19$.
- D. This stops after the inner function.

M02 • T1: NC.M4.AF.1.1 Compose two functions algebraically and preserve the order.**Answer: A. $3x-4$** Replace the input of f by $g(x)$: $f(3x)=3x-4$.**Check each alternative**

- A. Correct. Replace the input of f by $g(x)$: $f(3x)=3x-4$.
- B. This is $g(f(x))$.
- C. This is the product $f(x)g(x)$.
- D. This adds the two functions.

WORKED TEACHER KEYS

001 / 002**001 • T2: NC.M4.AF.1.2 Evaluate compositions from formulas, tables and graphs.**

$g(-2)=5$, so $f(g(-2))=13$. $f(-2)=-8$, so $g(f(-2))=65$. The different values show that reversing composition can change the result.

Full evidence: Both intermediate values, final outputs, and comparison. Partial credit: preserve and score a valid intermediate representation or justified step separately from the final accuracy.

002 • T1: NC.M4.AF.1.1 Compose two functions algebraically and preserve the order.

$f(g(x))=4-(2x+3)=1-2x$. $g(f(x))=2(4-x)+3=11-2x$. At 1 the values are -1 and 9, matching stage-by-stage evaluation.

Full evidence: Two substituted formulas, correct signs, and two checks. Partial credit: preserve and score a valid intermediate representation or justified step separately from the final accuracy.