

TEACHER AND STUDENT RESOURCE

Complex Number Operations



Precalculus • PC.N.1

Number and Quantity

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

PC.N.1 | North Carolina Precalculus mathematics

This sample contains 21 complete selected pages from the 95-page resource, plus this sample contents page. Original printed page numbers are retained. Gaps are intentional.

Included original pages: 1-16, 31-32, 61, 76-77

Representative activities

M01: sample PDF page(s) 17; original page(s) 16

M02: sample PDF page(s) 17; original page(s) 16

O01: sample PDF page(s) 18; original page(s) 31

O02: sample PDF page(s) 19; original page(s) 32

Selected teacher prompts and keys: original page(s) 61, 76-77

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.

PC.N.1 includes overlap with NC.M4.N.1. These are not wholly distinct task banks.

ALIGNMENT

Standard and learning targets

Apply properties of complex numbers and the complex number system.

T1 PC.N.1.1 Add and subtract complex numbers by matching components.

T2 PC.N.1.2 Multiply complex numbers and justify the i^2 substitution.

PC.N.1.1 Execute the sum and difference algorithms to combine complex numbers.

PC.N.1.2 Execute the multiplication algorithm with complex numbers.

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, M02, M04, M07, M09, M12, M15, M18, M20, M23, M24, O01, O02, O04, O07, O09, O12, O15, O18, O20, O23, O24, O27, O29

T2: M03, M05, M06, M08, M10, M11, M13, M14, M16, M17, M19, M21, M22, M25, M26, M27, M28, M29, M30, O03, O05, O06, O08, O10, O11, O13, O14, O16, O17, O19, O21, O22, O25, O26, O28, O30

DAILY LEARNING TARGETS

A multi-session teaching path

Session 1 Components and subtraction

Learning target: Add and subtract by components; verify with inverse operations.

Use M01-M04 and O01-O04 diagnostically, then model O05 and discuss selected We Do items.

Session 2 Product structure

Learning target: Distribute all factors; use $i^2 = -1$; explain conjugate products.

Use I Do and We Do tasks, then collaborative comparisons and constructions.

Session 3 Justify and transfer

Learning target: Use symbolic conditions, counterexamples, and independent checks.

Select independent tasks across both objectives. Reteach the evidenced gap, then collect O28-O30 as appropriate.

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 arithmetic, the distributive property, combining like terms, ordered pairs, and solving simple linear equations. Check $i^2 = -1$ explicitly before binomial multiplication.

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

Coefficients a and b in $a + bi$ are real. The real part is a ; the imaginary coefficient is b . A purely imaginary number has real part zero, including zero in this packet. Conjugates change the sign of the imaginary coefficient. Complex-plane extensions support operations, not division or polar-form requirements.

TEACHER ADAPTATION NOTE

Shared foundation, Precalculus transfer

Relationship to the Math 4 packet

This packet deliberately reuses 54 reviewed items from NC.M4.N.1 because PC.N.1 covers the same core addition, subtraction and multiplication algorithms. It is a Precalculus-aligned adaptation, not a separate original bank of 60 new questions. The six adapted items are M27, M29, M30, O20, O26 and O28.

What the transfer items add

The adapted tasks connect complex arithmetic to polynomial evaluation, real coefficients from conjugate factors, coefficient subtraction, composed transformations and iterated rules. They require the stated complex arithmetic, not polar form or complex division. Use them after students can justify the basic component and distributive steps.

Suggested teaching progression

Begin with the shared component and product tasks as needed. For transfer, ask which familiar arithmetic rule is hidden inside the new representation. Model one conjugate-pair polynomial product, then ask students to explain why the imaginary coefficients cancel. Use O20 to distinguish a polynomial identity from a single input value, and O26 to verify repeated work with a second representation.

TEACHER MODEL

Conjugate arithmetic creates real coefficients

Expand $(x-(2+i))(x-(2-i))$. Explain why the result has real coefficients rather than merely stating that imaginary terms cancel.

Write the middle coefficient as $-[(2+i)+(2-i)]=-4$. Compute the constant by distribution: $(2+i)(2-i)=4-2i+2i-i^2=5$. The leading coefficient is 1, so the product is x^2-4x+5 . The conjugate sum is real and the conjugate product is real for explicit arithmetic reasons. Ask learners to connect this calculation with the same sum and product rules used for individual complex numbers.

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: PC.N.1.1 Add and subtract complex numbers by matching components.

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

Represent $4 - 3i$ and $-2 + 5i$ as points on the complex plane. Add them and plot the sum. Explain how the coordinates match the algebra.

Teacher solution and discussion

The points are $(4, -3)$ and $(-2, 5)$. The sum is $(4 - 2) + (-3 + 5)i = 2 + 2i$, represented by $(2, 2)$. Real parts determine horizontal position; imaginary coefficients determine vertical position.

Evidence and response

Look for separate real and imaginary components, every distributive product, and an explicit use of $i^2 = -1$. If a sign error appears, have the learner undo subtraction by addition or isolate the imaginary-times-imaginary product. Use a new item to check transfer; an option alone cannot identify a 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 • T2: PC.N.1.2 Multiply complex numbers and justify the i^2 substitution.

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

Use a four-cell product organizer to expand $(3 - 2i)(-1 + 4i)$. Label each partial product before simplifying.

Teacher solution and discussion

The four products are -3 , $12i$, $2i$, and $-8i^2$. Since $-8i^2 = 8$, the real part is $-3 + 8 = 5$ and the imaginary part is $14i$. The product is $5 + 14i$.

Evidence and response

Look for separate real and imaginary components, every distributive product, and an explicit use of $i^2 = -1$. If a sign error appears, have the learner undo subtraction by addition or isolate the imaginary-times-imaginary product. Use a new item to check transfer; an option alone cannot identify a 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 • T1: PC.N.1.1 Add and subtract complex numbers by matching components.

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 real a, b , solve $(2a - 1) + (b + 3)i = 7 - 2i$. Then show a common invalid way to combine the components.

Teacher solution and discussion

Equal complex numbers have equal real and imaginary components: $2a - 1 = 7$ gives $a = 4$; $b + 3 = -2$ gives $b = -5$. Adding all coefficients into one real equation would lose the separate imaginary condition.

Evidence and response

Look for separate real and imaginary components, every distributive product, and an explicit use of $i^2 = -1$. If a sign error appears, have the learner undo subtraction by addition or isolate the imaginary-times-imaginary product. Use a new item to check transfer; an option alone cannot identify a 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: PC.N.1.2 Multiply complex numbers and justify the i^2 substitution.

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

Your group claims $(z + w)^2 = z^2 + w^2$ for every complex z, w . Use $z = 2 + i$ and $w = 1 - i$ to test the claim, then identify the missing term.

Teacher solution and discussion

$z + w = 3$, so the left side is 9. $z^2 = 3 + 4i$ and $w^2 = -2i$, so the right side is $3 + 2i$. The difference is $6 - 2i = 2zw$ because $zw = 3 - i$. The correct identity is $(z + w)^2 = z^2 + 2zw + w^2$.

Evidence and response

Look for separate real and imaginary components, every distributive product, and an explicit use of $i^2 = -1$. If a sign error appears, have the learner undo subtraction by addition or isolate the imaginary-times-imaginary product. Use a new item to check transfer; an option alone cannot identify a 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 • T2: PC.N.1.2 Multiply complex numbers and justify the i^2 substitution.

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

Simplify $(3 + i)(2 - 4i) - (1 - 2i)^2$. Show enough detail to locate a sign error in either product.

Teacher solution and discussion

The first product is $6 - 12i + 2i - 4i^2 = 10 - 10i$. The square is $1 - 4i + 4i^2 = -3 - 4i$. Subtracting gives $13 - 6i$.

Evidence and response

Look for separate real and imaginary components, every distributive product, and an explicit use of $i^2 = -1$. If a sign error appears, have the learner undo subtraction by addition or isolate the imaginary-times-imaginary product. Use a new item to check transfer; an option alone cannot identify a 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 • T1: PC.N.1.1 Add and subtract complex numbers by matching components.

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

On the complex plane, z is $(-2,4)$ and w is $(3,-1)$. Plot $z - w$. Explain why simply drawing the point for $w - z$ gives a different answer.

Teacher solution and discussion

$z - w = (-2 - 3) + (4 - (-1))i = -5 + 5i$, so plot $(-5,5)$. The reverse difference is $5 - 5i$, its reflection through the origin. They differ because z and w are unequal.

Evidence and response

Look for separate real and imaginary components, every distributive product, and an explicit use of $i^2 = -1$. If a sign error appears, have the learner undo subtraction by addition or isolate the imaginary-times-imaginary product. Use a new item to check transfer; an option alone cannot identify a 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 • T2: PC.N.1.2 Multiply complex numbers and justify the i^2 substitution.

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

Expand $(x-(1+2i))(x-(1-2i))(x+3)$ into a real-coefficient polynomial. Explain why the first two factors produce real coefficients, and verify directly from the factored form that $x=1+2i$ makes the polynomial zero.

Teacher solution and discussion

The conjugate pair gives $x^2-[(1+2i)+(1-2i)]x+(1+2i)(1-2i)=x^2-2x+5$. Multiplying by $x+3$ gives x^3+x^2-x+15 . The imaginary parts cancel in the sum and the product is $1-(2i)^2=5$, so all coefficients are real. At $x=1+2i$, the first factor is zero, so the entire factored expression is zero. This is a check using complex arithmetic, not an assumption that a real-coefficient polynomial has only real zeros.

Evidence and response

Look for separate real and imaginary components, every distributive product, and an explicit use of $i^2 = -1$. If a sign error appears, have the learner undo subtraction by addition or isolate the imaginary-times-imaginary product. Use a new item to check transfer; an option alone cannot identify a 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****Write $(3 + 4i) + (-5 + 2i)$ in $a + bi$ form.**

- A. $8 + 6i$
- B. $-2 + 6i$
- C. $-2 + 8i$
- D. $4i$

Reasoning: _____

M02 | Warm-up | T1**Which is the additive inverse of $-7 + 3i$?**

- A. $-7 - 3i$
- B. $7 + 3i$
- C. $7 - 3i$
- D. $1/(-7 + 3i)$

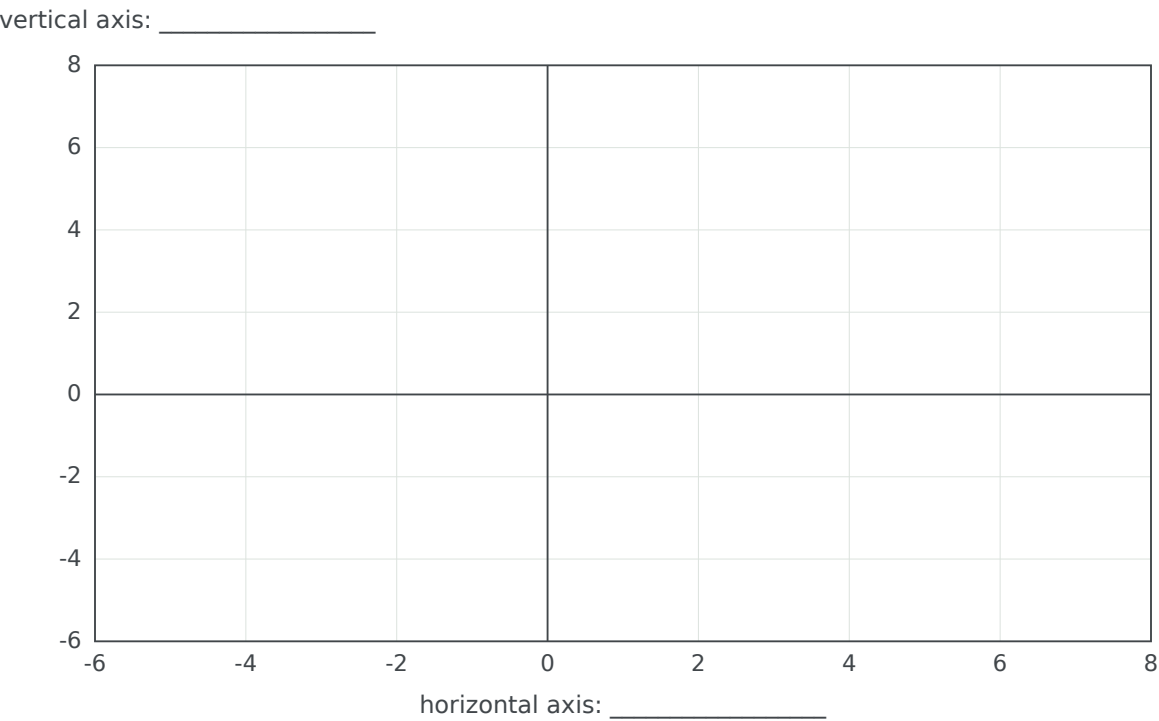
Reasoning: _____

WARM-UP

001 • Show your reasoning

T1: PC.N.1.1 Add and subtract complex numbers by matching components.

Represent $4 - 3i$ and $-2 + 5i$ as points on the complex plane. Add them and plot the sum. Explain how the coordinates match the algebra.



Explanation and check

WARM-UP

002 • Show your reasoning**T1: PC.N.1.1 Add and subtract complex numbers by matching components.****Find $a + bi$ so that $(a + bi) + (-3 + 7i) = 5 - i$. Verify by substitution.****Representation / calculation****Explanation / check**

WORKED TEACHER KEYS

M01 / M02**M01 • T1: PC.N.1.1 Add and subtract complex numbers by matching components.****Answer: B. $-2 + 6i$**

Group real parts $3 - 5 = -2$ and imaginary parts $(4 + 2)i = 6i$.

Check each alternative

- A. The real coefficient is $3 + (-5)$, not $3 + 5$.
- B. Correct. Group real parts $3 - 5 = -2$ and imaginary parts $(4 + 2)i = 6i$.
- C. The imaginary coefficient is $4 + 2 = 6$.
- D. Real and imaginary parts cannot be combined as like terms.

M02 • T1: PC.N.1.1 Add and subtract complex numbers by matching components.**Answer: C. $7 - 3i$**

The additive inverse negates both components, so $(-7 + 3i) + (7 - 3i) = 0$.

Check each alternative

- A. Only the imaginary sign changed; the sum would be -14 .
- B. Only the real sign changed; the sum would be $6i$.
- C. Correct. The additive inverse negates both components, so $(-7 + 3i) + (7 - 3i) = 0$.
- D. A reciprocal addresses multiplication, not addition.

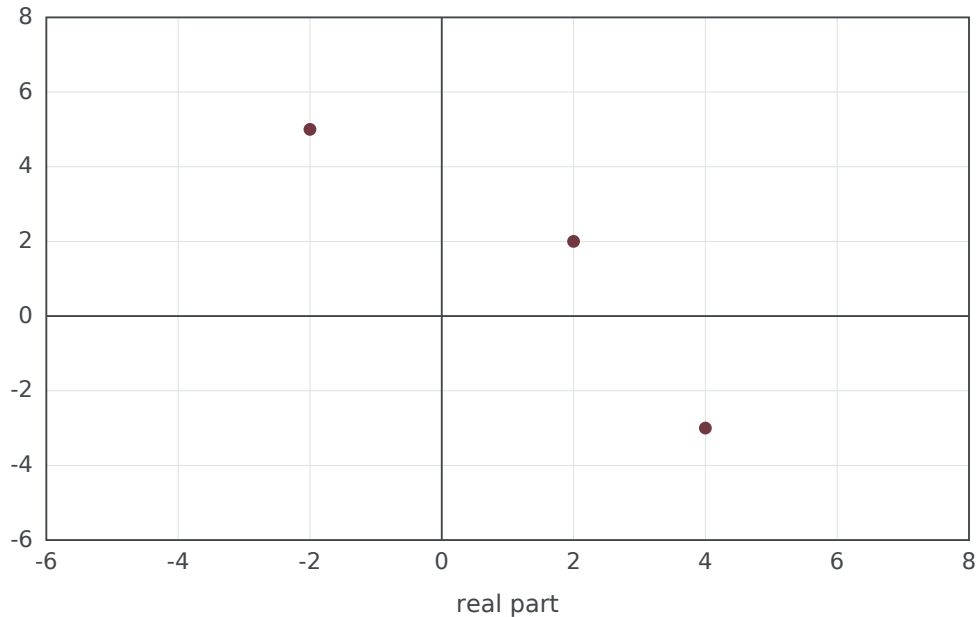
WORKED TEACHER KEYS

001

001 • T1: PC.N.1.1 Add and subtract complex numbers by matching components.

The points are $(4, -3)$ and $(-2, 5)$. The sum is $(4 - 2) + (-3 + 5)i = 2 + 2i$, represented by $(2, 2)$. Real parts determine horizontal position; imaginary coefficients determine vertical position.

imaginary part

**Evidence to assess**

Full evidence: Both given points, the point $(2, 2)$, and a componentwise explanation. Partial evidence: a valid intermediate representation with an error or missing justification. Record access and cues separately.

WORKED TEACHER KEYS

002 / 003**002 • T1: PC.N.1.1 Add and subtract complex numbers by matching components.**

Matching components gives $a - 3 = 5$ and $b + 7 = -1$, hence $a = 8$ and $b = -8$. Check: $(8 - 8i) + (-3 + 7i) = 5 - i$.

Full evidence: Both component equations, $8 - 8i$, and a substitution check. Partial evidence: a valid intermediate representation with an error or missing justification. Record access and cues separately.

003 • T2: PC.N.1.2 Multiply complex numbers and justify the i^2 substitution.

$i^2 = -1$; $i^3 = -i$; $i^4 = 1$; $i^5 = i$. In a binomial product the product of the two imaginary terms contains i^2 , which must be replaced by -1 .

Full evidence: The four powers and an explanation of the negative real contribution. Partial evidence: a valid intermediate representation with an error or missing justification. Record access and cues separately.