

TEACHER AND STUDENT RESOURCE

Creating and Graphing Relationships



NC Math 2 • NC.M2.A-CED.2

Creating Equations

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.M2.A-CED.2 | NC Math 2 mathematics

This sample contains 22 complete selected pages from the 124-page resource, plus this sample contents page. Original printed page numbers are retained. Gaps are intentional.

Included original pages: 1-16, 32-33, 62-63, 92-93

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) 32

O02: sample PDF page(s) 19; original page(s) 33

Selected teacher prompts and keys: original page(s) 62-63, 92-93

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

Create and graph equations in two variables to represent quadratic, square root and inverse variation relationships between quantities.

T1 Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

T2 Create and graph square-root relationships, including endpoints, shifts, restrictions and direction of change.

T3 Create and graph inverse-variation relationships, distinguishing constant products, continuous rates and discrete counts.

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, M04, O04, M05, O05, M09, O09, M13, O13, M14, O14, M15, O15, M19, O19, M22, O22, M24, O24, M28, O28

T2: M02, O02, M06, O06, M08, O08, M10, O10, O12, M16, O16, M18, O18, M20, O20, M25, O25, M27, O27, M30, O30

T3: M03, O03, M07, O07, M11, O11, M12, M17, O17, M21, O21, M23, O23, M26, O26, M29, O29

DAILY LEARNING TARGETS

A multi-session teaching path

Session 1 Identify and represent

Learning target: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

Learning target: Create and graph square-root relationships, including endpoints, shifts, restrictions and direction of change.

Use Warm-up, I Do, and early We Do tasks. Ask for a first response before showing the model.

Session 2 Explain and connect

Learning target: Create and graph square-root relationships, including endpoints, shifts, restrictions and direction of change.

Learning target: Create and graph inverse-variation relationships, distinguishing constant products, continuous rates and discrete counts.

Use We Do and collaborative tasks. Compare approaches and justify each step with the original conditions.

Session 3 Transfer independently

Learning target: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

Learning target: Create and graph square-root relationships, including endpoints, shifts, restrictions and direction of change.

Learning target: Create and graph inverse-variation relationships, distinguishing constant products, continuous rates and discrete counts.

Select independent items spanning the targets, reteach an evidenced gap, and use an unrehearsed exit item.

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

Coordinate pairs and axis scales, area and perimeter, principal square roots, constant products, quadratic expansion, and domain restrictions from physical quantities.

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.

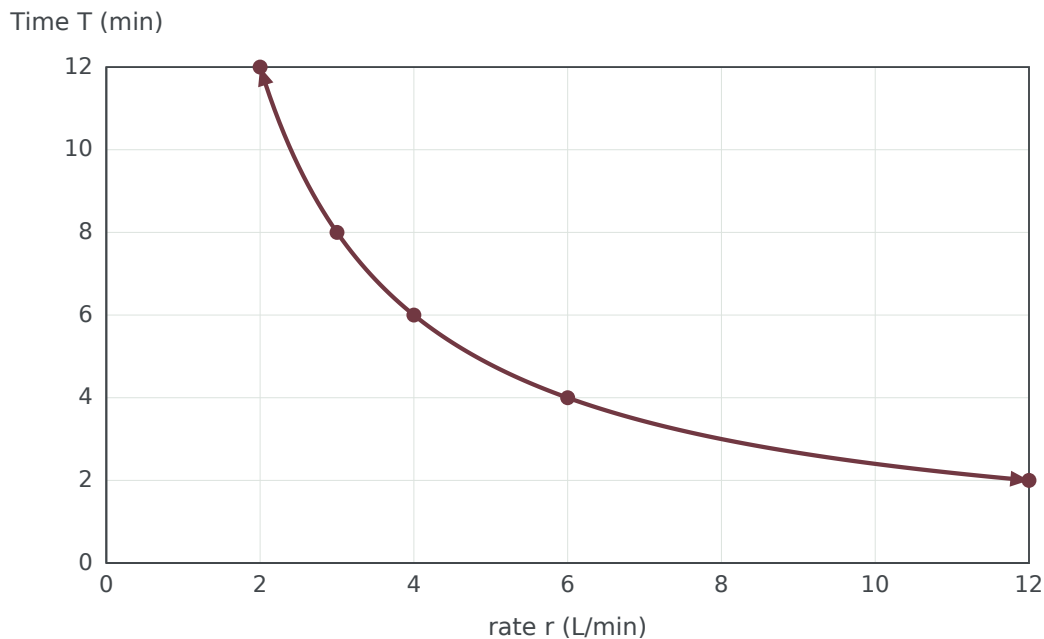
Review convention

Define each variable and unit. State which quantity is horizontal before writing ordered pairs. Draw smooth curves for continuous models, isolated points for integer counts, and show only the contextual domain. A plot window is not automatically the whole domain. Arrowheads indicate continuation, not an axis intersection. When two curves share a grid, label or key each one. Blank grids intentionally contain no teacher points or curves.

TEACHER MODEL

Build the equation, then choose the graph

A 24-liter tank fills at rate $r > 0$ liters per minute. Create a two-variable equation for fill time T , graph it, and explain why neither coordinate can be zero.



Volume equals rate times time: $rT=24$. Therefore $T=24/r$ for $r>0$. Points $(2, 12)$, $(3, 8)$, $(4, 6)$, $(6, 4)$, $(12, 2)$ have the same product 24. Draw a smooth decreasing curve rather than straight segments between sparse points. A zero rate would not fill the tank and makes the quotient undefined. At every finite positive rate, time remains positive; the curve approaches but does not cross the axes.

VISUAL ANCHOR

Three families, three checks

Use a quantity relationship to choose a family, then check multiple points rather than only an endpoint.

Relationship	Model	Graph evidence
Area from changing side	$A=3w^2$	Curved growth; $A/w^2=3$ for $w>0$
Side from area	$s=\sqrt{A}$	Nonnegative branch; starts at $(0, 0)$
Fixed work shared by rate	$T=24/r$	Constant product $rT=24$; no point at $r=0$

A curve may require a restricted interval, an included or excluded endpoint, or discrete points. These are mathematical features of the quantities, not decorative choices.

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: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

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 visual when present. Name the input and output, units, and physical restrictions. Ask learners to predict one point before choosing the family. Do not accept an equation that merely fits a single observed pair when the process implies more.

Core task

A rectangle is three times as long as its width w meters. Define its area A in terms of w . Graph the model for $0 \leq w \leq 4$, label units, and explain why the graph is not a straight line.

Teacher solution and discussion

$A = w(3w) = 3w^2$ square meters. Plot $(0, 0)$, $(1, 3)$, $(2, 12)$, $(3, 27)$, $(4, 48)$ and connect with the smooth upward-curving segment for $0 \leq w \leq 4$. Equal increases in width give area increases 3, 9, 15, 21, not a constant first difference; hence the graph is not linear.

Evidence and response

Assess the relationship before the sketch: does the equation follow from the quantities, and do plotted coordinates satisfy it? Require axis labels, scale, domain, relevant features and a model-based explanation. A visually plausible curve through two points does not establish a unique equation. Correctly matching a graph does not replace creating one.

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: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

Optional bank: M05–M08; 005–008. 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 005, including its visual when present. Derive the equation from area, elapsed time or fixed product. Make a short exact-value table, label axes and scales, then draw a curve consistent with the whole equation. State which endpoints and continuations belong to the context.

Core task

A rectangle has perimeter 20 m. Let x be one side and A its area. Derive the area equation, graph its full physical domain, and identify the greatest area and its dimensions. Use zero-area boundary points only as limiting endpoints.

Teacher solution and discussion

From $2x + 2L = 20$, $L = 10 - x$. Thus $A = x(10 - x) = 25 - (x - 5)^2$, with $0 < x < 10$. The curve approaches $(0, 0)$ and $(10, 0)$, which are excluded physical endpoints, and has maximum $(5, 25)$. Interior points include $(2, 16)$, $(4, 24)$, $(6, 24)$, $(8, 16)$. The maximum area is 25 m^2 for a 5-by-5 m square.

Evidence and response

Assess the relationship before the sketch: does the equation follow from the quantities, and do plotted coordinates satisfy it? Require axis labels, scale, domain, relevant features and a model-based explanation. A visually plausible curve through two points does not establish a unique equation. Correctly matching a graph does not replace creating one.

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: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

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 visual when present. Ask pairs to check each proposed point in the equation and challenge a line drawn through nonlinear endpoints. Discuss how axes, domains and curve families change what a point means.

Core task

A square tile order has cost $C=as^2+b$ dollars for side s meters. The fixed setup fee is \$6, and a 3 m square costs \$24. Determine a and b , graph the model for $0 \leq s \leq 4$, and interpret the intercept and curvature.

Teacher solution and discussion

The fixed fee gives $b=6$. Then $24=9a+6$, so $a=2$ dollars per square meter and $C=2s^2+6$. Points include $(0, 6)$, $(1, 8)$, $(2, 14)$, $(3, 24)$, $(4, 38)$. The intercept represents the setup fee at zero area; increasing steepness reflects the quadratic growth of area with side length.

Evidence and response

Assess the relationship before the sketch: does the equation follow from the quantities, and do plotted coordinates satisfy it? Require axis labels, scale, domain, relevant features and a model-based explanation. A visually plausible curve through two points does not establish a unique equation. Correctly matching a graph does not replace creating one.

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 • T1: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

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 visual when present. Assign one learner to derive, another to plot, and another to test claims. Swap roles. Require a concrete counterexample when a sketch or claim is wrong, and show how the corrected graph resolves it.

Core task

Design 1 is a square of side x . Design 2 is a rectangle of width x and length $x+2$. Create both area equations, graph them for $0 \leq x \leq 3$ on one plane, and explain algebraically how the vertical gap varies with x .

Teacher solution and discussion

The equations are $A_1 = x^2$ and $A_2 = x(x+2) = x^2 + 2x$. At $x=0, 1, 2, 3$ the first areas are 0, 1, 4, 9 and the second are 0, 3, 8, 15. Draw both upward curves; the key uses burgundy for A_1 and green for A_2 . The gap is $A_2 - A_1 = 2x$, so it increases linearly and is not a fixed vertical shift. At $x=0$ both are degenerate boundary designs.

Evidence and response

Assess the relationship before the sketch: does the equation follow from the quantities, and do plotted coordinates satisfy it? Require axis labels, scale, domain, relevant features and a model-based explanation. A visually plausible curve through two points does not establish a unique equation. Correctly matching a graph does not replace creating one.

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: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

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 visual when present. Preserve the first model and graph. Give only neutral access supports, not the function family or decisive plotted points. Collect equation, axes, domain, curve and interpretation as separate evidence.

Core task

A height model has maximum 12 m at $t=2$ s and reaches the ground at $t=0$ s and $t=4$ s. Construct a quadratic equation, graph the full flight, and verify all three conditions. Use the form $h=a(t-2)^2+12$ to determine a .

Teacher solution and discussion

Using $h(0)=0$ gives $4a+12=0$, so $a=-3$. Thus $h=-3(t-2)^2+12=-3t^2+12t$ for $0 \leq t \leq 4$. The vertex is (2, 12); $h(0)=h(4)=0$. Other points (1, 9), (3, 9) confirm symmetry. Draw the downward arc through these points with time and height units.

Evidence and response

Assess the relationship before the sketch: does the equation follow from the quantities, and do plotted coordinates satisfy it? Require axis labels, scale, domain, relevant features and a model-based explanation. A visually plausible curve through two points does not establish a unique equation. Correctly matching a graph does not replace creating one.

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: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

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 visual when present. Target the actual gap: squaring a whole length, choosing the principal branch, keeping the constant product, or respecting discrete inputs. Use the fresh task to test transfer without giving the missing point.

Core task

A learner models the area of a square of side $x+2$ cm as $A=x^2+4$. Correct the equation, use $x=1$ to diagnose the omitted contribution, and graph the correct model for $0 \leq x \leq 3$.

Teacher solution and discussion

$A=(x+2)^2=x^2+4x+4$. At $x=1$ the actual side is 3 cm and area 9 cm²; the incorrect expression gives 5 cm² because it omits $4x=4$. Plot (0, 4), (1, 9), (2, 16), (3, 25) with a smooth increasing quadratic segment.

Evidence and response

Assess the relationship before the sketch: does the equation follow from the quantities, and do plotted coordinates satisfy it? Require axis labels, scale, domain, relevant features and a model-based explanation. A visually plausible curve through two points does not establish a unique equation. Correctly matching a graph does not replace creating one.

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 • T1: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

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 visual when present. Use a new situation with a constraint. Require a defensible equation, an independently created graph, domain restrictions and a decision supported by a checked coordinate or interval.

Core task

A 3 m by 5 m garden is surrounded by a uniform path of width $w \geq 0$. Create an equation for path area P only, expand it, and graph for $0 \leq w \leq 2$. Explain the meaning of the origin and why the path-area graph is quadratic.

Teacher solution and discussion

Outside area is $(3+2w)(5+2w)$. Subtract the original 15 to get $P=4w^2+16w$. Points include $(0, 0)$, $(0.5, 9)$, $(1, 20)$, $(1.5, 33)$, $(2, 48)$. The origin represents no path when width is zero. The w^2 term arises because both outside dimensions change with w ; it makes the graph curved rather than linear.

Evidence and response

Assess the relationship before the sketch: does the equation follow from the quantities, and do plotted coordinates satisfy it? Require axis labels, scale, domain, relevant features and a model-based explanation. A visually plausible curve through two points does not establish a unique equation. Correctly matching a graph does not replace creating one.

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**

A square has side s meters and area A square meters. Which equation and point belong to its area graph?

- A. $A=4s$; (3, 12)
- B. $A=s^2$; (3, 9)
- C. $A=s^2$; (9, 3)
- D. $A=2s$; (3, 6)

Reasoning: _____

M02 | Warm-up | T2

A square has area $A \geq 0$ and nonnegative side s . With A horizontal, which equation describes the side graph?

- A. $s=\sqrt{A}$
- B. $s=4A$
- C. $s=\pm\sqrt{A}$
- D. $s=A^2$

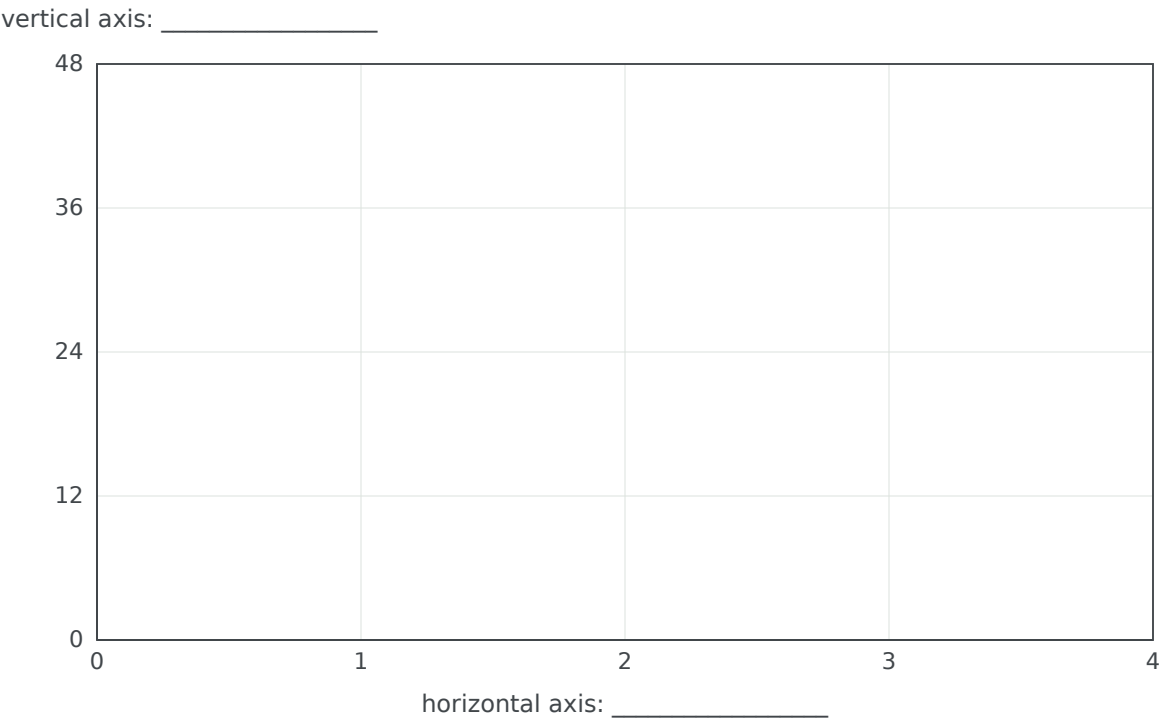
Reasoning: _____

WARM-UP

001 • Show your reasoning

T1: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

A rectangle is three times as long as its width w meters. Define its area A in terms of w . Graph the model for $0 \leq w \leq 4$, label units, and explain why the graph is not a straight line.



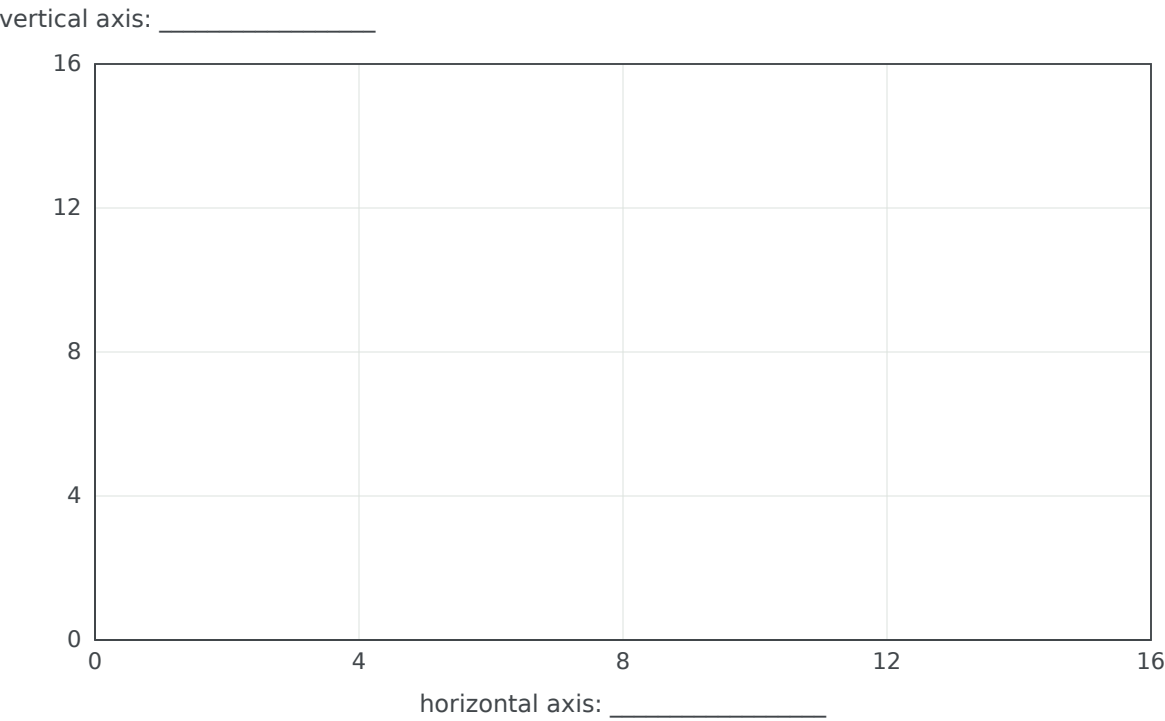
Explanation and check

WARM-UP

002 • Show your reasoning

T2: Create and graph square-root relationships, including endpoints, shifts, restrictions and direction of change.

Let $A \geq 0$ be the area of a square in cm^2 , allowing $A=0$ as a degenerate boundary. Create an equation for its perimeter P . Graph it for $0 \leq A \leq 16$ using at least four exact points and explain the decreasing steepness.



Explanation and check

WORKED TEACHER KEYS

M01

M01 • T1: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

Answer: B. $A=s^2$; (3, 9)

Area is side times side, so $A=s^2$. With s on the horizontal axis and A on the vertical axis, $s=3$ gives the point (3, 9).

Check each alternative

A. This is the perimeter relationship, not area.

B. Area is side times side, so $A=s^2$. With s on the horizontal axis and A on the vertical axis, $s=3$ gives the point (3, 9).

C. This reverses the ordered coordinates.

D. This doubles the side instead of squaring it.

Evidence to assess

Assess accurate representation, a valid justification, and a conclusion consistent with the domain and units. Accept equivalent reasoning or another construction meeting every condition. An answer alone does not establish a unique misconception.

WORKED TEACHER KEYS

M02

M02 • T2: Create and graph square-root relationships, including endpoints, shifts, restrictions and direction of change.

Answer: A. $s=\sqrt{A}$

The relation $A=s^2$ is solved for the nonnegative side by $s=\sqrt{A}$. Physical side lengths do not include a negative branch.

Check each alternative

- A. The relation $A=s^2$ is solved for the nonnegative side by $s=\sqrt{A}$. Physical side lengths do not include a negative branch.
- B. Multiplying area by 4 does not give a side length.
- C. The negative branch is not a nonnegative side.
- D. This squares the area instead of taking its root.

Evidence to assess

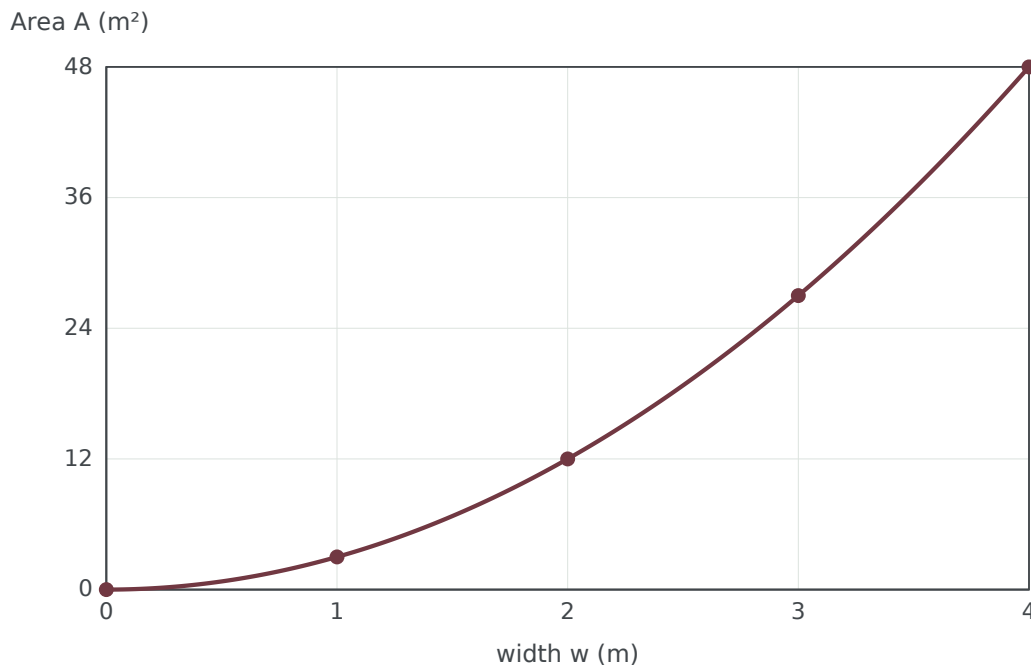
Assess accurate representation, a valid justification, and a conclusion consistent with the domain and units. Accept equivalent reasoning or another construction meeting every condition. An answer alone does not establish a unique misconception.

WORKED TEACHER KEYS

001

001 • T1: Create and graph quadratic relationships between quantities, with meaningful axes and contextual domains.

$A=w(3w)=3w^2$ square meters. Plot $(0, 0)$, $(1, 3)$, $(2, 12)$, $(3, 27)$, $(4, 48)$ and connect with the smooth upward-curving segment for $0 \leq w \leq 4$. Equal increases in width give area increases 3, 9, 15, 21, not a constant first difference; hence the graph is not linear.



Evidence to assess

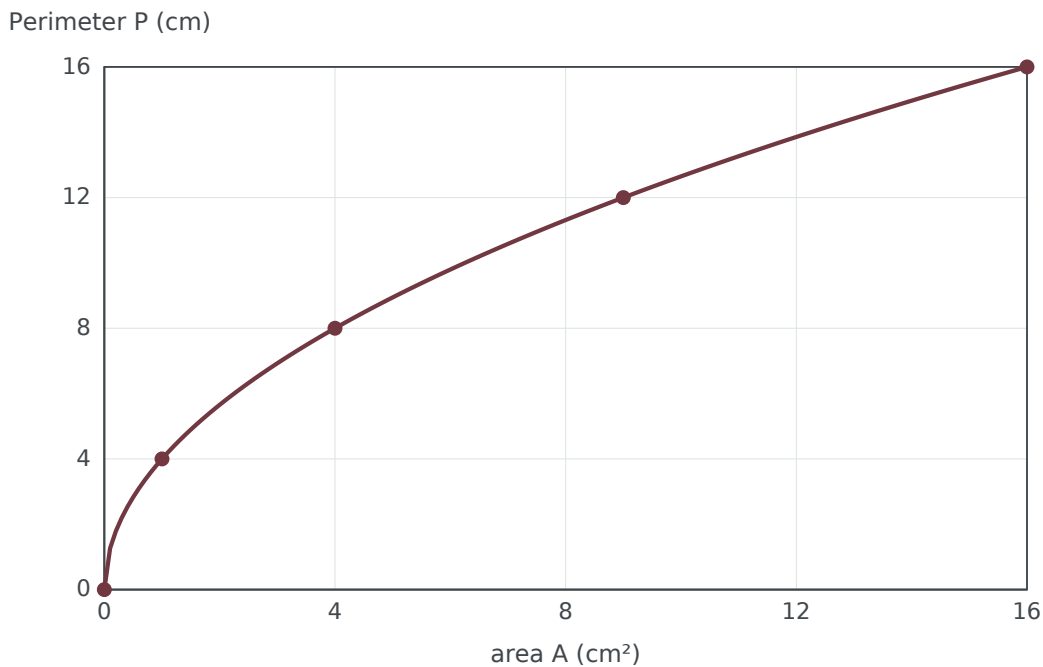
Require the product-based equation, labeled axes, correct points and smooth restricted curve, and a nonconstant-rate explanation.

WORKED TEACHER KEYS

002

002 • T2: Create and graph square-root relationships, including endpoints, shifts, restrictions and direction of change.

Each side is $\sqrt{A}$, so $P=4\sqrt{A}$ cm. Exact points include $(0, 0)$, $(1, 4)$, $(4, 8)$, $(9, 12)$, $(16, 16)$. Draw the increasing root curve. Equal 4 cm increases in perimeter require area increases 1, 3, 5, 7, so the graph becomes less steep as A grows.

**Evidence to assess**

Require the root-based perimeter equation, at least four exact points, axis units, and an increasing curve with decreasing steepness.