

TEACHER AND STUDENT RESOURCE

Represent and Analyze Functions



NC Math 1 • NC.M1.F-IF.7

Linear, exponential and quadratic functions

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.F-IF.7 | NC Math 1 mathematics

This sample contains 20 complete selected pages from the 107-page resource, plus this sample contents page. Original printed page numbers are retained. Gaps are intentional.

Included original pages: 1-15, 30-31, 60, 75-76

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, 75-76

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

Analyze linear, exponential, and quadratic functions by generating different representations, by hand in simple cases and using technology for more complicated cases, to show key features, including: domain and range; rate of change; intercepts; intervals where the function is increasing, decreasing, positive, or negative; maximums and minimums; and end behavior.

T1 Generate and connect tables, graphs and formulas.

T2 Determine domain, range and intercepts.

T3 Analyze rates, direction and signs on intervals.

T4 Analyze extrema and end behavior.

T5 Use technology to generate and verify 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, M13, M18, M24, O01, O08, O13, O18, O24

T2: M01, M05, M08, M11, M16, M19, M22, M26, O02, O05, O10, O15, O21, O25, O30

T3: M04, M06, M09, M12, M15, M20, M23, M27, M30, O03, O06, O09, O12, O17, O20, O26, O29

T4: M03, M07, M10, M14, M17, M25, M28, O04, O07, O11, O14, O22, O27

T5: M21, M29, O16, O19, O23, O28

PLANNING

Materials, access and pacing

Materials

Pencils, erasers, straightedge and student pages. A graphing calculator or graphing app is required for O16, O19, O23 and O28; prepare device access before these tasks. No paid software is required. Use hand methods for the other tasks.

Prerequisites

Evaluate expressions, plot ordered pairs, solve simple linear equations, recognize squares and use interval notation. Review x-intercepts as inputs where the output is zero.

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

Unless restricted, formulas have their full real domain. Intervals of increase/decrease and positivity/negativity use open endpoints; separately state included domain endpoints and zeros. Average rate on $[a,b]$ is $(f(b) - f(a))/(b - a)$. Curves continue beyond a displayed window unless a domain restriction is given.

TEACHER MODEL

One formula, connected evidence

Analyze $f(x) = (x - 1)^2 - 4$. Generate a table and graph by hand, then connect the key features.

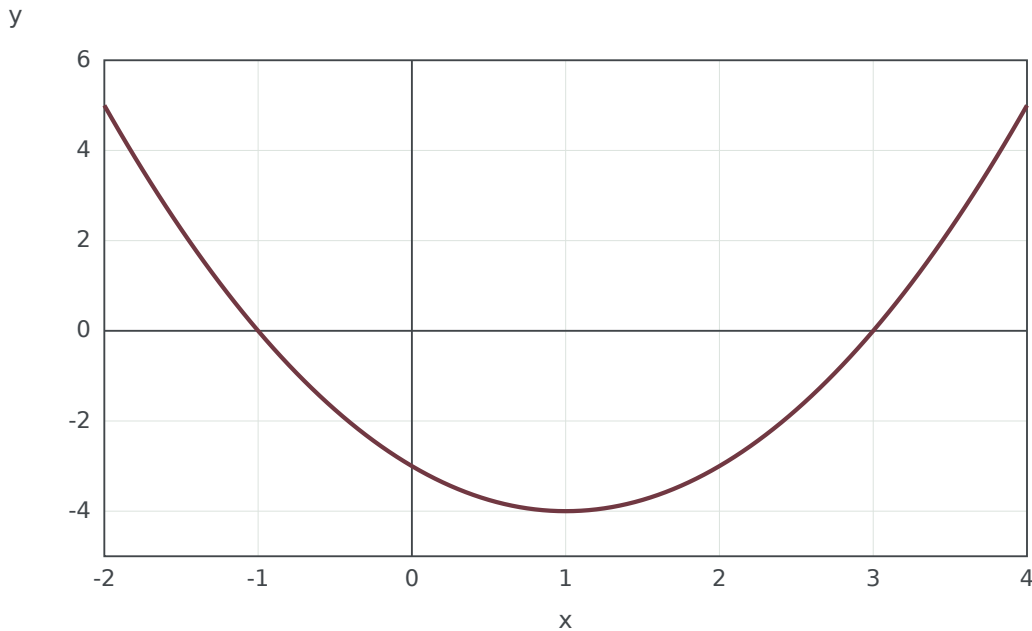


Table: $x = -2, -1, 0, 1, 2, 3, 4$ gives $y = 5, 0, -3, -4, -3, 0, 5$. The vertex $(1, -4)$ gives minimum -4 and range $[-4, \infty)$; domain is all real numbers. Intercepts: $(-1, 0)$, $(3, 0)$, $(0, -3)$. Decreases left of 1; increases right of 1. Positive outside the roots, negative between them. Both ends rise. Rate on $[0, 2]$ is $(-3 - (-3))/2 = 0$, despite changing outputs inside the interval; average rate is not a claim that the function is constant.

VISUAL ANCHOR

Choose evidence for a feature

Use more than one representation to check a claim. A window edge is not a mathematical endpoint.

Feature	Useful evidence	Check or caution
Intercepts	Set $x = 0$ or $y = 0$	Report ordered pairs; check the domain.
Direction / rate	Compare outputs; compute $\Delta y/\Delta x$	Average rates may vary by interval.
Range / extrema	Vertex, endpoints or asymptote	A bound may never be attained.
End behavior	Formula and an expanded graph	A finite window cannot show infinity.

Simple cases: table and sketch by hand. Complicated cases: enter the exact formula in a graphing calculator/app, record the window and table, use trace/zero/extremum tools, and verify a sampled value by substitution. Device commands vary; no paid product is required.

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: Generate and connect tables, graphs and formulas.

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

By hand, make a table for $f(x) = 2x + 1$ at $x = -2, -1, 0, 1, 2$. Graph the line and label both intercepts. Explain how the table shows its rate.

Teacher solution and discussion

Outputs are $-3, -1, 1, 3, 5$. Plot these points and join with a line continuing both ways. The y-intercept is $(0, 1)$; $2x + 1 = 0$ gives $(-0.5, 0)$. Each unit input increase adds 2 to the output, so the constant rate is 2.

Evidence and response

Look for a claim tied to a generated table, graph, formula or verified feature. On technology tasks, collect the entered formula, settings, table and tool results. If a learner only names an answer, ask which values or parts of the graph support it. If a graph-window edge is treated as a domain bound, expand the view and check another input, then collect fresh evidence. 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 • T2: Determine domain, range and intercepts.

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 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

For $f(x) = -2x + 6$ restricted to $0 \leq x \leq 5$, build a table at integers 0 through 5 and graph it. State range and intercepts. Mark included endpoints.

Teacher solution and discussion

The outputs are 6, 4, 2, 0, -2 , -4 . Draw only the segment from $(0, 6)$ to $(5, -4)$, with solid endpoints. Range: $-4 \leq y \leq 6$. Intercepts: $(0, 6)$ and $(3, 0)$. These are all outputs between the endpoint outputs because the line is continuous.

Evidence and response

Look for a claim tied to a generated table, graph, formula or verified feature. On technology tasks, collect the entered formula, settings, table and tool results. If a learner only names an answer, ask which values or parts of the graph support it. If a graph-window edge is treated as a domain bound, expand the view and check another input, then collect fresh evidence. 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: Analyze rates, direction and signs on intervals.

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 $f(x) = 3x - 9$, graph by hand and identify where outputs are positive, zero or negative. Compare average rates on $[-1, 1]$ and $[2, 5]$.

Teacher solution and discussion

The points $(0, -9)$, $(3, 0)$, $(5, 6)$ define the line. Positive when $x > 3$; zero at $x = 3$; negative when $x < 3$. $f(-1) = -12$, $f(1) = -6$, so the first rate is $6/2 = 3$. $f(2) = -3$ and $f(5) = 6$, so the second is $9/3 = 3$. Both agree with the slope.

Evidence and response

Look for a claim tied to a generated table, graph, formula or verified feature. On technology tasks, collect the entered formula, settings, table and tool results. If a learner only names an answer, ask which values or parts of the graph support it. If a graph-window edge is treated as a domain bound, expand the view and check another input, then collect fresh evidence. 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 • T4: Analyze extrema and end behavior.

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 ball has modeled height $h(t) = -t^2 + 6t$ meters for $0 \leq t \leq 6$ seconds. Graph by hand using integer times. Find maximum height, range, and increasing/decreasing intervals on this domain.

Teacher solution and discussion

At $t = 0, 1, 2, 3, 4, 5, 6$, heights are 0, 5, 8, 9, 8, 5, 0. $h(t) = -(t - 3)^2 + 9$ gives maximum 9 m at 3 s. Range: $0 \leq h \leq 9$. Increasing on $(0, 3)$, decreasing on $(3, 6)$, with endpoints included in the domain. The minimum 0 m occurs at $t = 0$ and 6. Do not extend the physical graph outside $[0, 6]$.

Evidence and response

Look for a claim tied to a generated table, graph, formula or verified feature. On technology tasks, collect the entered formula, settings, table and tool results. If a learner only names an answer, ask which values or parts of the graph support it. If a graph-window edge is treated as a domain bound, expand the view and check another input, then collect fresh evidence. 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 • T5: Use technology to generate and verify representations.

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

Use technology for $g(x) = 7.5(1.18^x) - 10$. Enter the formula and generate values at $x = 0, 2, 4, 6, 8$. Start with $-5 \leq x \leq 10$, $-8 \leq y \leq 30$. Find the zero using the device and sketch the curve. Record window and table, domain/range, intercepts and end behavior. Round numerical results to 2 decimals.

Teacher solution and discussion

Table outputs are $-2.50, 0.44, 4.54, 10.25, 18.19$ (rounded). The zero is $x \approx 1.74$, so intercepts are $(1.74, 0)$ approximately and $(0, -2.5)$. Domain: all real x ; range: $y > -10$. As $x \rightarrow -\infty$, outputs approach -10 from above; as $x \rightarrow \infty$, outputs grow without bound. Entering 1.18^x requires the exponent x , not multiplication by x . Preserve the device-generated table and window as evidence.

Evidence and response

Look for a claim tied to a generated table, graph, formula or verified feature. On technology tasks, collect the entered formula, settings, table and tool results. If a learner only names an answer, ask which values or parts of the graph support it. If a graph-window edge is treated as a domain bound, expand the view and check another input, then collect fresh evidence. 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 • T1: Generate and connect tables, graphs and formulas.

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

A learner plots $y = 2^x$ as a straight line through (0, 1) and (2, 4). Make a table at $x = -1, 0, 1, 2, 3$ and graph the correct curve. Explain one numerical reason the straight line is wrong.

Teacher solution and discussion

The outputs are 0.5, 1, 2, 4, 8. The line through (0, 1) and (2, 4) has slope 1.5 and predicts 2.5 at $x = 1$, but the function gives 2. Unit output changes double rather than stay constant. Draw a smooth increasing exponential curve through the five points.

Evidence and response

Look for a claim tied to a generated table, graph, formula or verified feature. On technology tasks, collect the entered formula, settings, table and tool results. If a learner only names an answer, ask which values or parts of the graph support it. If a graph-window edge is treated as a domain bound, expand the view and check another input, then collect fresh evidence. 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 • T5: Use technology to generate and verify representations.

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

Use technology to graph $f(x) = 9(0.82^x) - 2$. Start with $-2 \leq x \leq 12$ and $-2 \leq y \leq 12$. Generate a table at $x = 0, 3, 6, 9, 12$. Record settings and sketch the curve. Find the zero to 2 decimals, and report sign intervals, range and right-end behavior.

Teacher solution and discussion

Table outputs rounded to 2 decimals: 7.00, 2.96, 0.74, -0.49 , -1.17 . The zero is $x \approx 7.58$. Positive for x below the exact zero and negative above it; output zero at the root. Range: $y > -2$. As $x \rightarrow \infty$, outputs approach -2 from above. The curve is decreasing on all real inputs. Keep device evidence; the approximate zero is a rounded interval boundary.

Evidence and response

Look for a claim tied to a generated table, graph, formula or verified feature. On technology tasks, collect the entered formula, settings, table and tool results. If a learner only names an answer, ask which values or parts of the graph support it. If a graph-window edge is treated as a domain bound, expand the view and check another input, then collect fresh evidence. 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 | T2****For $f(x) = 2x - 6$, which ordered pair is the x-intercept?**

- A. $(0, -6)$
- B. $(0, 3)$
- C. $(-3, 0)$
- D. $(3, 0)$

Reasoning: _____

M02 | Warm-up | T1**Which table fits $f(x) = 3(2^x)$ at $x = 0, 1, 2$?**

- A. 1, 2, 4
- B. 0, 6, 12
- C. 3, 5, 7
- D. 3, 6, 12

Reasoning: _____

WARM-UP

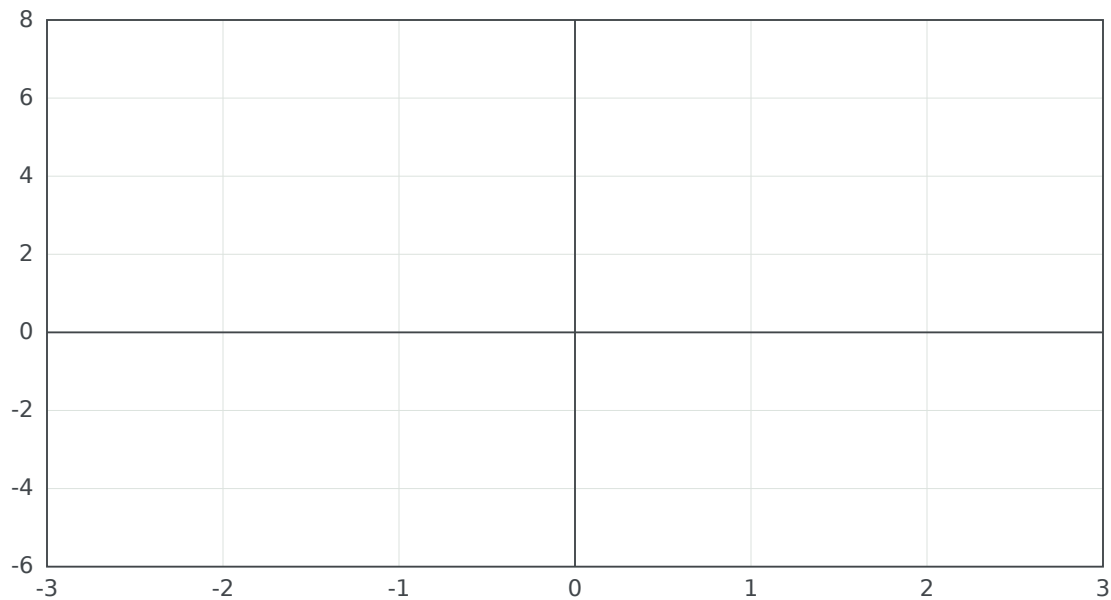
001 • Show your reasoning

T1: Generate and connect tables, graphs and formulas.

By hand, make a table for $f(x) = 2x + 1$ at $x = -2, -1, 0, 1, 2$. Graph the line and label both intercepts. Explain how the table shows its rate.

Input x	Output f(x)

vertical axis: _____



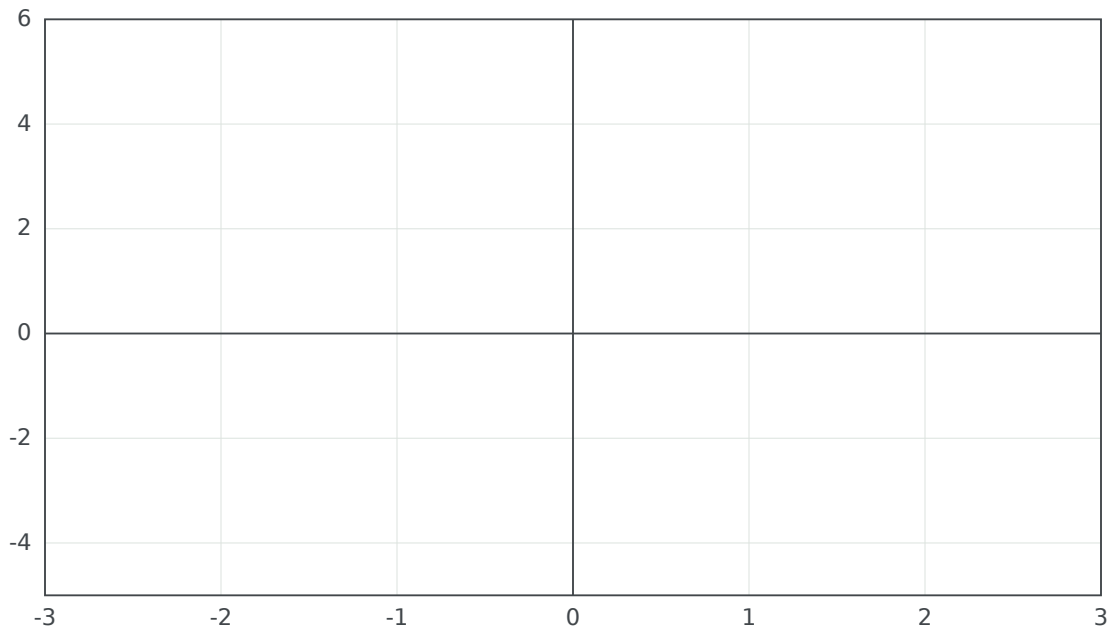
horizontal axis: _____

Explanation and check

WARM-UP

002 • Show your reasoning**T2: Determine domain, range and intercepts.****By hand, graph $f(x) = x^2 - 4$ using inputs -3 through 3 . State the domain, range and intercepts.**

vertical axis: _____



horizontal axis: _____

Explanation and check

WORKED TEACHER KEYS

M01 / M02**M01 • T2: Determine domain, range and intercepts.****Answer: D. (3, 0)**

Set $2x - 6 = 0$. Then $x = 3$, so the x-intercept is (3, 0).

Check each alternative

- A. This is the y-intercept.
- B. $f(0) = -6$, not 3.
- C. $f(-3) = -12$, not 0.
- D. $2(3) - 6 = 0$.

M02 • T1: Generate and connect tables, graphs and formulas.**Answer: D. 3, 6, 12**

The powers are 1, 2, 4; multiplying by 3 gives 3, 6, 12.

Check each alternative

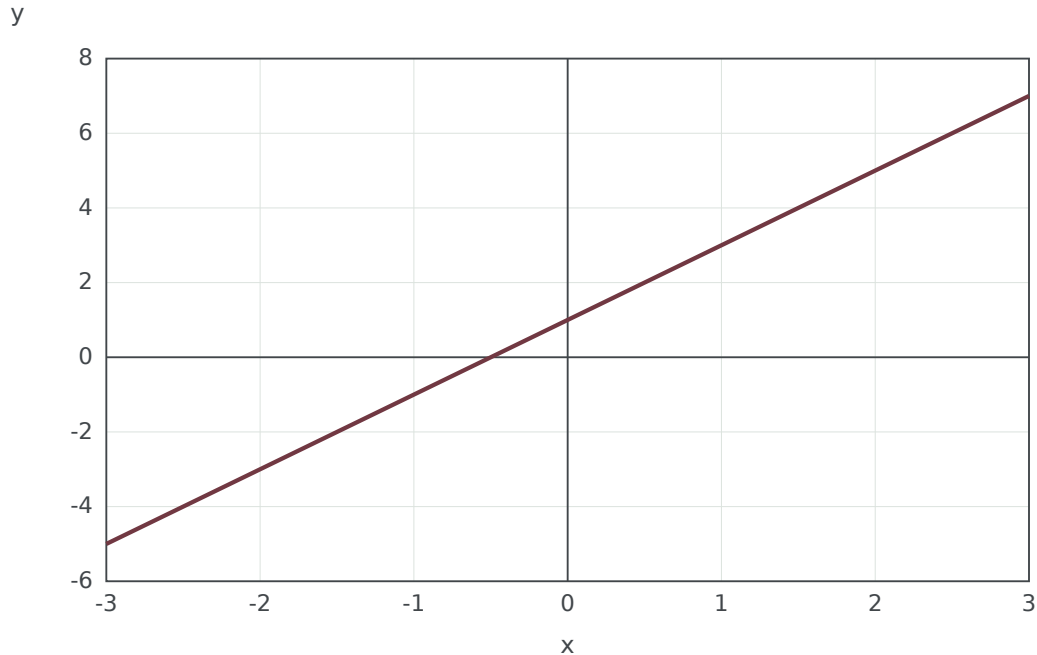
- A. Omits the coefficient 3.
- B. At zero, $2^0 = 1$, not 0.
- C. Adds 2 instead of multiplying by 2.
- D. All three outputs match.

WORKED TEACHER KEYS

001

001 • T1: Generate and connect tables, graphs and formulas.

Outputs are $-3, -1, 1, 3, 5$. Plot these points and join with a line continuing both ways. The y -intercept is $(0, 1)$; $2x + 1 = 0$ gives $(-0.5, 0)$. Each unit input increase adds 2 to the output, so the constant rate is 2.

**Evidence to assess**

Check the plotted representation against the listed coordinates and formula. Assess every requested feature, endpoint convention and explanation. The teacher curve shows the stated window; a window edge is not automatically a domain endpoint.

WORKED TEACHER KEYS

002

002 • T2: Determine domain, range and intercepts.

The outputs for $-3, -2, -1, 0, 1, 2, 3$ are $5, 0, -3, -4, -3, 0, 5$. Draw a smooth upward parabola. Domain: all real numbers. Range: $y \geq -4$. The y-intercept is $(0, -4)$. Solving $x^2 = 4$ gives x-intercepts $(-2, 0)$ and $(2, 0)$.

**Evidence to assess**

Check the plotted representation against the listed coordinates and formula. Assess every requested feature, endpoint convention and explanation. The teacher curve shows the stated window; a window edge is not automatically a domain endpoint.