

TEACHER AND STUDENT RESOURCE

Parametric Models and Technology Investigations



Precalculus • PC.F.7

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

PC.F.7 | North Carolina Precalculus mathematics

This sample contains 23 complete selected pages from the 106-page resource, plus this sample contents page. Original printed page numbers are retained. Gaps are intentional.

Included original pages: 1-18, 33-34, 63, 78-79

Representative activities

M01: sample PDF page(s) 19; original page(s) 18

M02: sample PDF page(s) 19; original page(s) 18

O01: sample PDF page(s) 20; original page(s) 33

O02: sample PDF page(s) 21; original page(s) 34

Selected teacher prompts and keys: original page(s) 63, 78-79

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.
Its required companion lab is included with the complete paid download.
The sample does not include that complete companion archive.

ALIGNMENT

Standard and learning targets

Apply mathematical reasoning to build parametric functions and solve problems.

T1 PC.F.7.1 Use algebraic methods to represent situations with parametric equations.

T2 PC.F.7.2 Use technology to solve contextual problems involving parametric equations.

PC.F.7.1 Implement algebraic methods to represent a situation using parametric equations.

PC.F.7.2 Implement technology to solve contextual problems involving parametric equations.

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, M03, M05, M07, M09, M11, M13, M15, M17, M19, M21, M23, M25, M27, M29, O01, O03, O05, O07, O09, O11, O13, O15, O17, O19, O21, O23, O25, O27, O29

T2: M02, M04, M06, M08, M10, M12, M14, M16, M18, M20, M22, M24, M26, M28, M30, O02, O04, 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: PC.F.7.1 Use algebraic methods to represent situations with parametric equations.

Learning target: PC.F.7.2 Use technology to solve contextual problems involving parametric equations.

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

Session 2 Compare and explain

Learning target: PC.F.7.2 Use technology to solve contextual problems involving parametric equations.

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

Graphing calculator in parametric mode or the supplied Python laboratory (numpy and scipy); pencils and graph paper. No calculus is required for student methods. The lab includes sampled paths and reproducible root/optimization calculations, with exact algebraic teacher checks where available.

Prerequisites

Coordinate geometry, vector components, trigonometric functions in radians, algebraic equations and graph interpretation.

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 a task explicitly changes units, t is elapsed seconds and x, y are meters. Angles are radians. A parametric point is $(x(t), y(t))$ at one shared parameter value. A geometric path does not determine timing, direction or speed by itself. Collision requires both objects to have equal coordinates at the same time; a crossing of drawn paths is insufficient. Include the physical parameter domain. Use equal spatial coordinate scales when interpreting shape or distance. Numerical answers are rounded to three decimals only after calculations with unrounded values.

TECHNOLOGY LABORATORY

Set up an event investigation

Student protocol

Enter $x(t)$, $y(t)$ and the full physical t interval in parametric mode. Use equal x/y scales for shape, then inspect $x(t)$, $y(t)$, or a distance function against time to locate an event. Record a bracket and refine with a solver. Return the same time to both coordinate equations. Retain unrounded values for checks.

Files and reproducibility

The technology_lab folder has 11 original model CSV files with 241 regular samples each, plus courier transition times when needed. `source/parametric_lab.py` recreates these and `teacher_verified_results.json`. These are invented instructional models, not observed motion data. Keep teacher results separate until students have recorded independent evidence.

What software does not establish

A coarse sample may miss a crossing; tangency can occur without a sign change. A path intersection may correspond to different times. Bounded optimization is used on the stated unimodal intervals, not as a universal global guarantee. Check endpoints and algebraic identities when available.

Evidence to retain

Record the equations, time interval, graph window and numerical method, then all relevant roots or candidates, their coordinates, units and contextual interpretation. A screenshot or rounded number alone is not a complete solution.

TECHNOLOGY MODELS A THROUGH D

Projectiles, rotation and simultaneous motion

A: projectile

$x=12t$, $y=1+16t-5t^2$, from launch $t=0$ until first positive ground contact. Use a provisional t interval $[0,4]$ to locate landing, then restrict to physical flight. Spatial window $0 \leq x \leq 42$, $0 \leq y \leq 16$.

B: wheel seat

$x=10\sin(\pi t/20)$, $y=12-10\cos(\pi t/20)$, $0 \leq t \leq 40$. The circle has center $(0,12)$, radius 10 and starts at its bottom. Spatial window $-12 \leq x \leq 12$, $0 \leq y \leq 24$; for height versus time use $0 \leq t \leq 40$ and $0 \leq y \leq 24$.

C: robots

$A(t)=(2t,1+t)$, $B(t)=(12-t,9-t)$, $0 \leq t \leq 6$, measured from one shared start time. Spatial window $0 \leq x \leq 13$, $0 \leq y \leq 10$. Collision means both coordinate differences vanish at the same time.

D: walkers

$A(t)=(t,0)$, $B(t)=(4,3-t)$, $0 \leq t \leq 6$. Spatial window $-1 \leq x \leq 7$, $-4 \leq y \leq 4$; distance-versus-time window $0 \leq t \leq 6$, $0 \leq d \leq 6$. The separately labeled synchronized variant changes only B to $(4,4-t)$.

TECHNOLOGY MODELS E THROUGH H

Zones, waiting and curved paths

E: inspection drone

$x=6\cos t$, $y=3\sin t$, $0\leq t\leq 2\pi$. Spatial window $-7\leq x\leq 7$, $-4\leq y\leq 4$. The parameter advances at 1 radian per second. Sensor-zone conditions apply to both coordinates at the same time.

F: courier

For $0\leq t\leq 3$, $(x,y)=(2t,0)$; for $3\leq t\leq 5$, $(6,0)$; for $5\leq t\leq 9$, $(6,2(t-5))$. The overlapping endpoint formulas agree. Spatial window $-1\leq x\leq 7$, $-1\leq y\leq 9$. The courier moves east, waits two seconds, then moves north.

G: oscillating arm tip

$x=2\cos t$, $y=\sin(2t)$, $0\leq t\leq 2\pi$. Spatial window $-3\leq x\leq 3$, $-2\leq y\leq 2$. The path can cross itself. For the unit-disc investigation, graph $d^2(t)=x(t)^2+y(t)^2$ with comparison level 1.

H: spiral rover

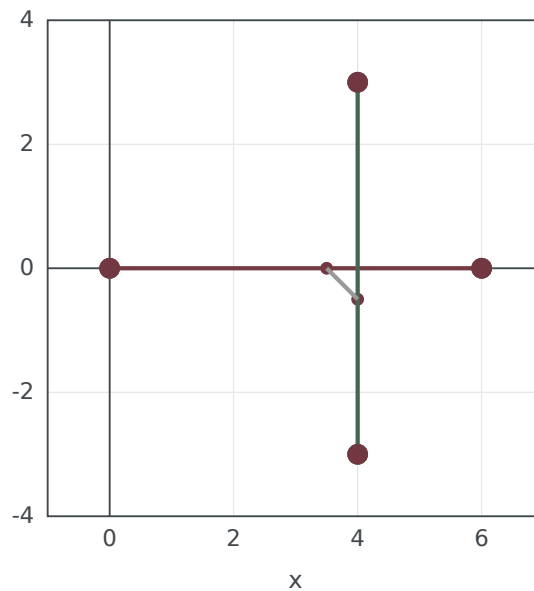
$x=t\cos t$, $y=t\sin t$, $0\leq t\leq 2\pi$. Spatial window $-7\leq x\leq 7$, $-7\leq y\leq 7$. Its radius grows at 1 meter per second while its angle grows at 1 radian per second. For upper-arc events restrict to $0\leq t\leq \pi$.

TEACHER MODEL

A path crossing is not a collision

Two walkers follow $A(t)=(t, 0)$ and $B(t)=(4, 3-t)$, $0 \leq t \leq 6$. Their paths cross at $(4, 0)$. Do they meet there?

y



A reaches $(4, 0)$ when $t=4$; B reaches it when $t=3$. They never occupy it at the same time. The shared-time squared distance is $(t-4)^2 + (t-3)^2 = 2(t-3.5)^2 + 0.5$, so even the closest approach is $\sqrt{0.5}$ meters, not zero. Parametric timing is part of the model, not a decoration on its geometric path.

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: O01 • T1: PC.F.7.1 Use algebraic methods to represent situations with parametric 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

A robot travels from $(-3, 4)$ to $(9, -2)$ in exactly 6 seconds at constant velocity. Build parametric equations with the physical time domain, find the velocity components and speed, and sketch the directed path.

Teacher solution and discussion

The displacement is $(12, -6)$, so velocity is $(2, -1)$ m/s. Thus $x = -3 + 2t$, $y = 4 - t$ for $0 \leq t \leq 6$. The speed is $\sqrt{2^2 + (-1)^2} = \sqrt{5}$ m/s. The endpoint checks give $(-3, 4)$ at $t = 0$ and $(9, -2)$ at $t = 6$. Sketch the segment with direction from the first point to the second, not the entire supporting line.

Evidence and response

For algebraic models, check starting point, direction, rates, endpoint and parameter domain. For technology tasks, record equations, parameter interval, spatial window, tool method and event times; verify coordinates by substitution. Compare every relevant event and feasible endpoint. Separate numerical evidence from a general proof about an arbitrary curve.

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: PC.F.7.1 Use algebraic methods to represent situations with parametric equations.

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

Build a model for a point moving counterclockwise around a circle centered at $(1, 2)$, radius 4 meters, starting at the bottom and completing one turn in 8 seconds. Give five quarter-turn positions with times and sketch the directed circle.

Teacher solution and discussion

The angular rate is $2\pi/8 = \pi/4$ radians per second. Use $x = 1 + 4 \sin(\pi t/4)$, $y = 2 - 4 \cos(\pi t/4)$, $0 \leq t \leq 8$. At $t = 0, 2, 4, 6, 8$ the positions are $(1, -2)$, $(5, 2)$, $(1, 6)$, $(-3, 2)$, $(1, -2)$. From the bottom, counterclockwise motion initially goes right. The equation $(x-1)^2 + (y-2)^2 = 16$ verifies the constant radius.

Evidence and response

For algebraic models, check starting point, direction, rates, endpoint and parameter domain. For technology tasks, record equations, parameter interval, spatial window, tool method and event times; verify coordinates by substitution. Compare every relevant event and feasible endpoint. Separate numerical evidence from a general proof about an arbitrary curve.

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: O09 • T1: PC.F.7.1 Use algebraic methods to represent situations with parametric equations.

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

A ball is launched from height 1.5 meters at speed 20 m/s and angle 30° above horizontal. Use downward acceleration 10 m/s^2 . Build parametric equations, derive the exact positive landing time and give the physical parameter domain. Explain the horizontal and vertical components.

Teacher solution and discussion

Horizontal velocity is $20\cos 30^\circ = 10\sqrt{3} \text{ m/s}$ and vertical velocity is $20\sin 30^\circ = 10 \text{ m/s}$. Therefore $x = 10\sqrt{3}t$, $y = 1.5 + 10t - 5t^2$. Ground contact solves $5t^2 - 10t - 1.5 = 0$, so $T = (10 + \sqrt{130})/10 = 1 + \sqrt{130}/10$; the other root is negative. The physical domain is $0 \leq t \leq T$. The horizontal component is constant while gravity contributes $-(10/2)t^2$ vertically. The landing distance is $10\sqrt{3} \cdot T = 10\sqrt{3} + \sqrt{390}$ meters.

Evidence and response

For algebraic models, check starting point, direction, rates, endpoint and parameter domain. For technology tasks, record equations, parameter interval, spatial window, tool method and event times; verify coordinates by substitution. Compare every relevant event and feasible endpoint. Separate numerical evidence from a general proof about an arbitrary curve.

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.F.7.2 Use technology to solve contextual problems involving parametric equations.

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

Use Model G to find all origin visits and all maximum-height events during $0 \leq t \leq 2\pi$. Give exact times and coordinates, confirm them numerically, and sketch the directed self-crossing path. Explain why the origin crossing is not a collision between two objects.

Teacher solution and discussion

The origin occurs at $t = \pi/2$ and $3\pi/2$, approximately 1.571 and 4.712 seconds. Maximum height $y=1$ occurs when $2t = \pi/2 + 2k\pi$: $t = \pi/4$ and $5\pi/4$, approximately 0.785 and 3.927, at $(\sqrt{2}, 1)$ and $(-\sqrt{2}, 1)$. The same arm tip visits the origin at two different times; this is a self-intersection of one trajectory, not evidence of two objects colliding. Trace increasing t to distinguish the two passes.

Evidence and response

For algebraic models, check starting point, direction, rates, endpoint and parameter domain. For technology tasks, record equations, parameter interval, spatial window, tool method and event times; verify coordinates by substitution. Compare every relevant event and feasible endpoint. Separate numerical evidence from a general proof about an arbitrary curve.

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: PC.F.7.1 Use algebraic methods to represent situations with parametric equations.

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

A platform's center is $C(t)=(t, 0)$. A point rotates around that center with radius 2, angle $\pi t/2$, and starts to the center's right. Build the ground-coordinate model for $0 \leq t \leq 4$, list positions at integer times and explain why the ground path is not a fixed circle.

Teacher solution and discussion

Add center and relative position: $x=t+2 \cos(\pi t/2)$, $y=2 \sin(\pi t/2)$, $0 \leq t \leq 4$. At $t=0, 1, 2, 3, 4$ the positions are $(2, 0)$, $(1, 2)$, $(0, 0)$, $(3, -2)$, $(6, 0)$. The point stays radius 2 from the moving center, but not from one fixed ground point. Translation and rotation combine into a noncircular ground trajectory.

Evidence and response

For algebraic models, check starting point, direction, rates, endpoint and parameter domain. For technology tasks, record equations, parameter interval, spatial window, tool method and event times; verify coordinates by substitution. Compare every relevant event and feasible endpoint. Separate numerical evidence from a general proof about an arbitrary curve.

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: PC.F.7.2 Use technology to solve contextual problems involving parametric equations.

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

Use Model E to find every closest approach to a stationary sensor at (4, 0) during one turn. Report times, positions and minimum distance to three decimals. Verify the global minimum by expressing squared distance as a quadratic in $c = \cos t$ and checking its feasible domain.

Teacher solution and discussion

$d^2 = (6 \cos t - 4)^2 + 9 \sin^2 t = 27c^2 - 48c + 25 = 27(c - 8/9)^2 + 11/3$, with $-1 \leq c \leq 1$. The minimizing $c = 8/9$ is feasible, so $d_{\min} = \sqrt{11/3} \approx 1.915$ meters. Times are $\arccos(8/9) \approx 0.475882249$ and $2\pi - \arccos(8/9) \approx 5.807303058$. Positions are $(16/3, \pm\sqrt{17/3}) \approx (5.333, \pm 1.374)$. A solver on the upper half followed by symmetry finds both, and the nonnegative square proves the global minimum over the full turn.

Evidence and response

For algebraic models, check starting point, direction, rates, endpoint and parameter domain. For technology tasks, record equations, parameter interval, spatial window, tool method and event times; verify coordinates by substitution. Compare every relevant event and feasible endpoint. Separate numerical evidence from a general proof about an arbitrary curve.

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.F.7.2 Use technology to solve contextual problems involving parametric equations.

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 Model G to find all times in $[0, 2\pi]$ when the arm tip lies inside or on the unit disc. Report four boundary times, both qualifying intervals and total duration to three decimals. Give an algebraic identity that independently checks the radial condition.

Teacher solution and discussion

$d^2 = 4\cos^2 t + \sin^2(2t) = 4\cos^2 t(1 + \sin^2 t) = 4(1 - \sin^4 t)$. Thus $d^2 \leq 1$ is equivalent to $\sin^4 t \geq 3/4$. Let $\alpha = \arcsin((3/4)^{1/4}) \approx 1.196061894$. The qualifying intervals are $[\alpha, \pi - \alpha]$ and $[\pi + \alpha, 2\pi - \alpha]$, approximately $[1.196, 1.946]$ and $[4.338, 5.087]$. Their total duration is $2\pi - 4\alpha \approx 1.498937731$ seconds. A dense plot of d^2 with level 1 and four refined roots confirms both visits; the boundary points are included.

Evidence and response

For algebraic models, check starting point, direction, rates, endpoint and parameter domain. For technology tasks, record equations, parameter interval, spatial window, tool method and event times; verify coordinates by substitution. Compare every relevant event and feasible endpoint. Separate numerical evidence from a general proof about an arbitrary curve.

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 robot starts at $(-2, 3)$ and has constant velocity 4 m/s east and 1 m/s south. Which model uses elapsed seconds $t \geq 0$?

- A. $x=4-2t$, $y=-1+3t$
- B. $x=-2+4t$, $y=3-t$
- C. $x=-2-4t$, $y=3+t$
- D. $x=-2+4t$, $y=3+t$

Reasoning: _____

M02 | Warm-up | T2

Use technology with Model A, $x=12t$, $y=1+16t-5t^2$. Which is the positive ground-contact time, to three decimals?

- A. 3.261 seconds
- B. 0.061 seconds
- C. 1.600 seconds
- D. 39.136 seconds

Reasoning: _____

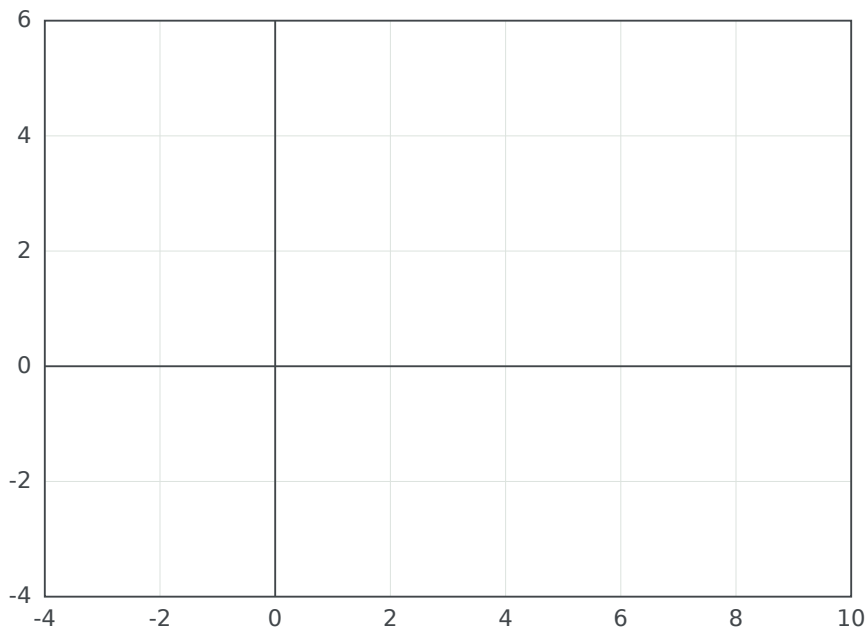
WARM-UP

001 • Show your reasoning

T1: PC.F.7.1 Use algebraic methods to represent situations with parametric equations.

A robot travels from $(-3, 4)$ to $(9, -2)$ in exactly 6 seconds at constant velocity. Build parametric equations with the physical time domain, find the velocity components and speed, and sketch the directed path.

vertical axis: _____



horizontal axis: _____

Explanation and check

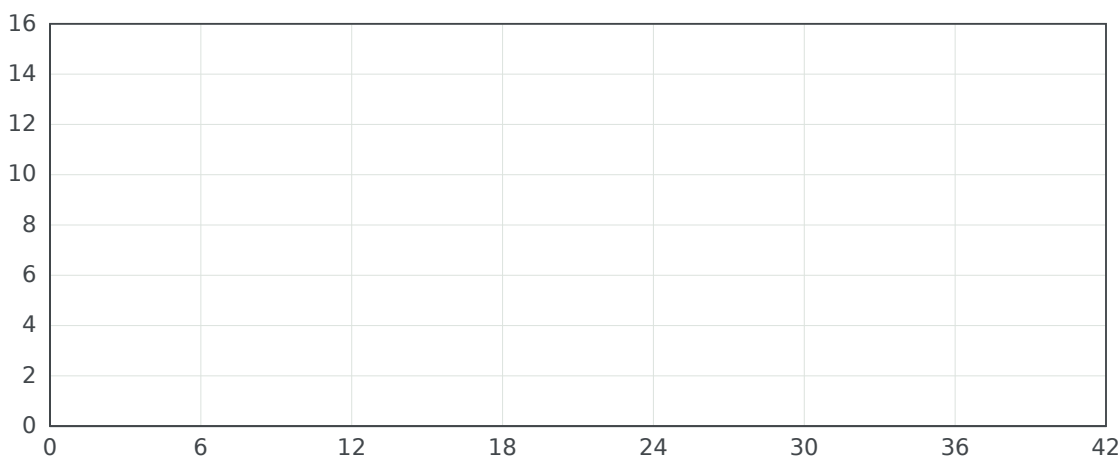
WARM-UP

002 • Show your reasoning

T2: PC.F.7.2 Use technology to solve contextual problems involving parametric equations.

Use Model A, $x=12t$, $y=1+16t-5t^2$, to find the physical flight interval, landing point and maximum-height event. Record a technology setup, give results to three decimals, verify algebraically and sketch the physical trajectory.

vertical axis: _____



horizontal axis: _____

Explanation and check

WORKED TEACHER KEYS

M01 / M02

M01 • T1: PC.F.7.1 Use algebraic methods to represent situations with parametric equations.

Answer: B. $x = -2 + 4t$, $y = 3 - t$

Add each velocity component times t to its corresponding starting coordinate.

Check each alternative

- A. This exchanges starting coordinates with velocity components.
- B. Correct. Add each velocity component times t to its corresponding starting coordinate.
- C. This reverses both motion directions.
- D. Southward motion requires the y -coordinate to decrease.

M02 • T2: PC.F.7.2 Use technology to solve contextual problems involving parametric equations.

Answer: A. 3.261 seconds

Solve $y(t) = 0$ in $[0, 4]$. The positive root is $(16 + \sqrt{276})/10 \approx 3.261324773$; substitute it into both coordinates for the landing event.

Check each alternative

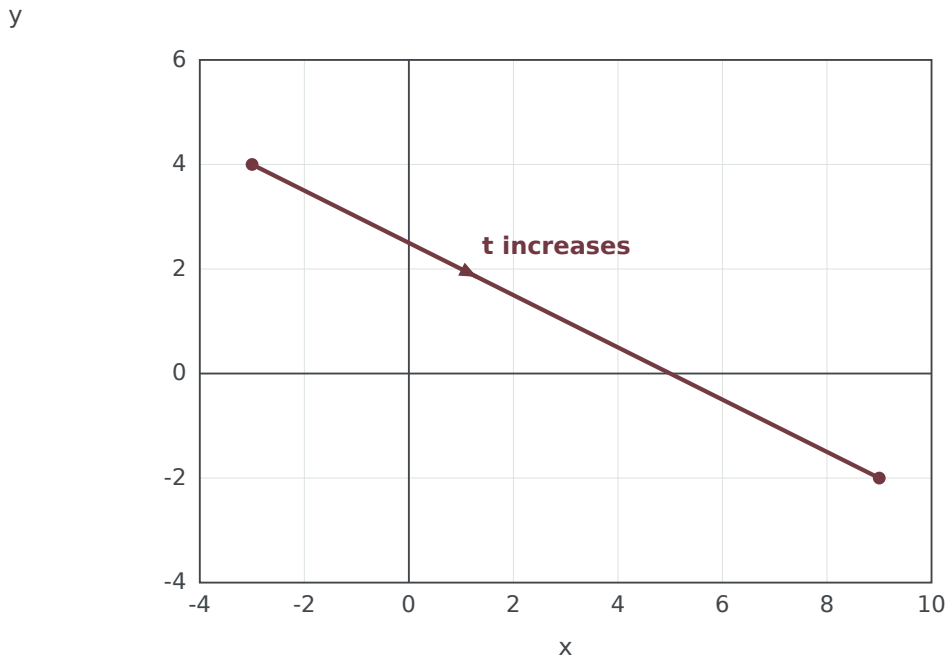
- A. Correct. Solve $y(t) = 0$ in $[0, 4]$. The positive root is $(16 + \sqrt{276})/10 \approx 3.261324773$; substitute it into both coordinates for the landing event.
- B. The other quadratic root is approximately -0.061 , not a positive landing time.
- C. This is the time of maximum height, not ground contact.
- D. This is the horizontal landing distance in meters, not the time.

WORKED TEACHER KEYS

001

001 • T1: PC.F.7.1 Use algebraic methods to represent situations with parametric equations.

The displacement is $(12, -6)$, so velocity is $(2, -1)$ m/s. Thus $x = -3 + 2t$, $y = 4 - t$ for $0 \leq t \leq 6$. The speed is $\sqrt{2^2 + (-1)^2} = \sqrt{5}$ m/s. The endpoint checks give $(-3, 4)$ at $t=0$ and $(9, -2)$ at $t=6$. Sketch the segment with direction from the first point to the second, not the entire supporting line.

**Evidence to assess**

Full evidence: Both equations and units, physical interval, velocity/speed, endpoint checks and a directed finite segment. Partial credit: preserve and score a valid intermediate representation or justified step separately from the final accuracy.

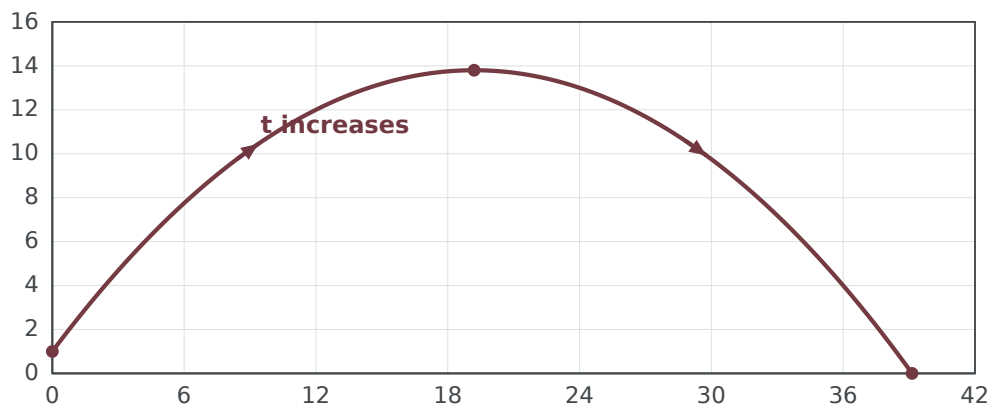
WORKED TEACHER KEYS

002

002 • T2: PC.F.7.2 Use technology to solve contextual problems involving parametric equations.

Use $t \in [0, 4]$ provisionally and spatial window $0 \leq x \leq 42$, $0 \leq y \leq 16$; refine the positive root of $y=0$. Landing time is $T=(16+\sqrt{276})/10 \approx 3.261$ seconds and $x(T) \approx 39.136$ meters. The physical interval is $[0, T]$, not all of $[0, 4]$. Completing the square gives $y=13.8-5(t-1.6)^2$, so the maximum is at $t=1.600$, point $(19.200, 13.800)$. The negative root is before launch and is rejected. The plotted physical arc begins at $(0, 1)$ and ends on the ground.

y



x

Evidence to assess

Full evidence: Technology window and refined root, contextual time restriction, landing and maximum coordinates with units, exact checks and a physical-only graph. Partial credit: preserve and score a valid intermediate representation or justified step separately from the final accuracy.