

TEACHER AND STUDENT RESOURCE

Trigonometric Features and Contextual Models



Precalculus • PC.F.1

Advanced Mathematics

Seven instructional sections with 30 multiple-choice and 30 open or performance tasks, teaching scripts, original mathematical visuals, generous workspaces, and worked keys.

Free sample | Contents

PC.F.1 | North Carolina Precalculus mathematics

This sample contains 22 complete selected pages from the 101-page resource, plus this sample contents page. Original printed page numbers are retained. Gaps are intentional.

Included original pages: 1-17, 33-34, 63, 79-80

Representative activities

M01: sample PDF page(s) 18; original page(s) 17

M02: sample PDF page(s) 18; original page(s) 17

O01: sample PDF page(s) 19; original page(s) 33

O02: sample PDF page(s) 20; original page(s) 34

Selected teacher prompts and keys: original page(s) 63, 79-80

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

Understand key features of sine, cosine, tangent, cotangent, secant and cosecant functions.

T1 PC.F.1.1 Interpret transformed sine and cosine features, including intervals, extrema and frequency.

T2 PC.F.1.2 Interpret tangent, cotangent, secant and cosecant features, domains and asymptotes.

T3 PC.F.1.3 Build trigonometric functions from specified features and contextual information.

T4 PC.F.1.4 Solve contextual trigonometric equations and inequalities using algebra and technology.

PC.F.1.1 Interpret algebraic and graphical representations to determine key features of transformed sine and cosine functions. Key features include: amplitude, domain, midline, phase shift, frequency, period, intervals where the function is increasing, decreasing, positive or negative, relative maximums and minimums.

PC.F.1.2 Interpret algebraic and graphical representations to determine key features of tangent, cotangent, secant, and cosecant. Key features include: domain, frequency, period, intervals where the function is increasing, decreasing, positive or negative, relative maximums and minimums, and asymptotes.

PC.F.1.3 Integrate information to build trigonometric functions with specified amplitude, frequency, period, phase shift, or midline with or without context.

PC.F.1.4 Implement graphical and algebraic methods to solve trigonometric equations and inequalities in context with support from technology.

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, M05, M09, M13, M17, M21, M25, M27, O01, O05, O09, O13, O17, O21, O25, O29

T2: M02, M06, M10, M14, M18, M22, M26, M28, O02, O06, O10, O14, O18, O22, O26, O30

T3: M03, M07, M11, M15, M19, M23, M29, O03, O07, O11, O15, O19, O23, O27

T4: M04, M08, M12, M16, M20, M24, M30, O04, O08, O12, O16, O20, O24, O28

DAILY LEARNING TARGETS

A multi-session teaching path

Session 1 Diagnose and model

Learning target: PC.F.1.1 Interpret transformed sine and cosine features, including intervals, extrema and frequency.

Learning target: PC.F.1.2 Interpret tangent, cotangent, secant and cosecant features, domains and asymptotes.

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.1.2 Interpret tangent, cotangent, secant and cosecant features, domains and asymptotes.

Learning target: PC.F.1.3 Build trigonometric functions from specified features and contextual information.

Learning target: PC.F.1.4 Solve contextual trigonometric equations and inequalities using algebra and technology.

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

Scientific or graphing calculator in radian mode, pencils and straightedge. Optional free Python technology lab uses numpy and scipy. All original model formulas, windows, sample CSV files and reproducible solver are included; no paid account is required.

Prerequisites

Unit-circle values, radians, inverse trigonometric functions, interval notation and graph transformations.

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

Angles are in radians unless explicitly labeled otherwise. Frequency means cycles per input unit, $f=1/P$, not the angular coefficient B . For $A \sin(B(x-C))+D$ or $A \cos(B(x-C))+D$ with A and B nonzero, amplitude is $|A|$ and $P=2\pi/|B|$. Tangent and cotangent have $P=\pi/|B|$. Secant and cosecant have $P=2\pi/|B|$ and no amplitude. Use integer k in periodic descriptions. Use open intervals between turning points to describe increase or decrease. In sign sets, include a restricted-domain endpoint when it satisfies the sign condition; domain exclusions remain excluded. A phase-shift description is not unique because adding a whole period gives an equivalent model.

TEACHER REFERENCE

Features are more than coefficient labels

Sine and cosine

Their domain is all real numbers. A negative outside coefficient reflects the graph; it does not create a negative amplitude. A vertical shift can remove all zeros or alter positive intervals. Derive monotonic intervals from one full cycle and then translate by the period.

Reciprocal and quotient functions

$\tan x = \sin x / \cos x$ and $\sec x = 1 / \cos x$ exclude zeros of cosine. $\cot x = \cos x / \sin x$ and $\csc x = 1 / \sin x$ exclude zeros of sine. Tangent and cotangent have no local extrema on their branches. Secant and cosecant do have local extrema, even though their global ranges are unbounded.

Frequency and phase

State whether a quantity is cycles per unit or radians per unit. In this packet, frequency always means $1/P$. Factor the argument before reading the phase shift. Equivalent sine/cosine models can have different-looking phase shifts.

Intervals, not a sketch alone

Do not join intervals across an asymptote. Strict inequalities exclude crossings; non-strict inequalities include crossings that lie in the domain. A discrete sample table can miss threshold crossings or a short interval above a threshold.

TECHNOLOGY LABORATORY

Graph, intersect, test and verify

Files and models

The accompanying technology_lab folder contains A_tide_samples.csv, B_wheel_samples.csv and C_composite_samples.csv, each with 25 equally spaced samples. These are original instructional models, not measured environmental data. source/trig_lab.py regenerates the samples and verified_crossings.json. Keep the verification file as a teacher key until students finish.

Model A: tide height

$H(t) = 3 + 2\sin(\pi t/6)$, in meters, for $0 \leq t \leq 12$ hours. Use window $0 \leq t \leq 12$ and $0 \leq H \leq 6$. Compare with $H = 4$. Use a graphing intersection command, then verify exactly with unit-circle angles.

Model B: observation wheel

$h(t) = 11 - 9\cos(\pi t/20)$, in meters, for $0 \leq t \leq 40$ seconds. Use window $0 \leq t \leq 40$ and $0 \leq h \leq 22$. Compare with $h = 15$. Retain unrounded intersection values when computing a duration.

Model C: combined oscillation

$C(t) = 3 + \sin t + 0.5\cos(2t)$, in meters, for $0 \leq t \leq 2\pi$ hours. Use window $0 \leq t \leq 2\pi$ and $1 \leq C \leq 4$. Compare with $C = 3.6$. There can be more than two crossings in one period; do not stop after finding the first pair.

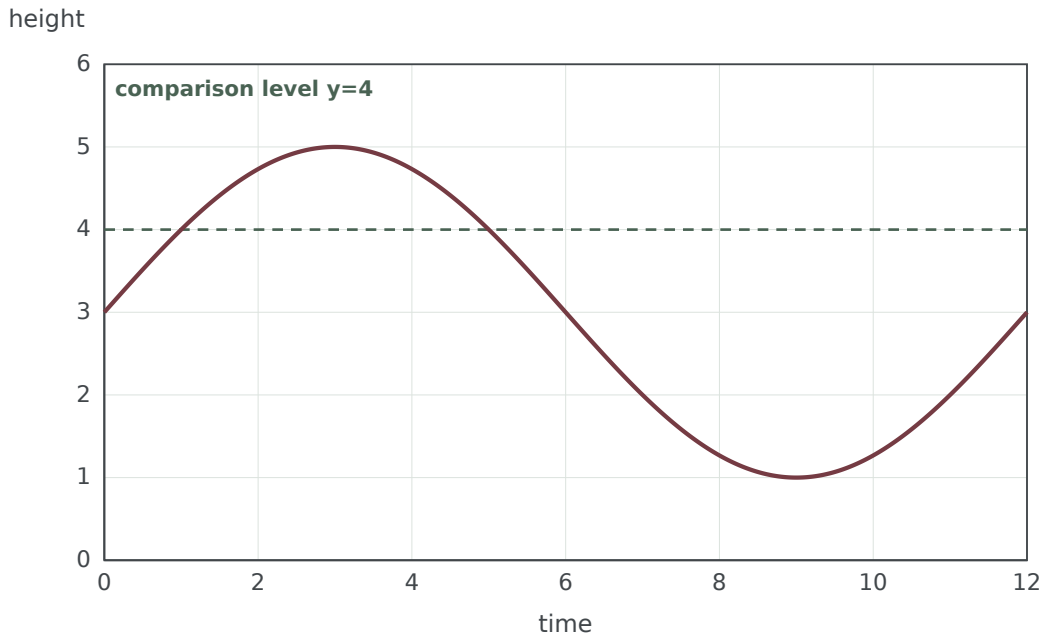
Required student protocol

Set radian mode and the stated window. Graph the model and horizontal comparison line; record every crossing with units. Test one point between consecutive crossings and at relevant endpoints. Verify using an algebraic equation. If using Python, run the supplied script, explain its bracketing method and check the reported roots by substitution. A sample table is supporting evidence, not a continuous solution.

TEACHER MODEL

A threshold is an interval, not just two roots

For $H(t)=3+2 \sin(\pi t/6)$ meters on $0 \leq t \leq 12$ hours, use a graph and algebra to find when $H(t) \geq 4$.



Use radians and graph the model with $y=4$ in a window covering the entire 12-hour period.

The intersection equation gives $\sin(\pi t/6)=1/2$, so $t=1$ and 5 hours. Test $t=3$: $H=5>4$.

Therefore $H \geq 4$ on $[1, 5]$, a total of 4 hours. Include the crossing times because the inequality is non-strict; the domain endpoints have height 3 and do not qualify. A sample table alone is not a proof that every crossing has been found.

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.F.1.1 Interpret transformed sine and cosine features, including intervals, extrema and frequency.

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

Analyze $y = -4 \cos[2(x - \pi/6)] + 3$. State domain, amplitude, midline, period, frequency in cycles per unit, range and a direct phase shift. Identify one minimum and the next maximum.

Teacher solution and discussion

The domain is all real x . Amplitude is 4, midline $y=3$, period π and frequency $1/\pi$. The range is $[-1, 7]$, and the factored form gives a shift right $\pi/6$. At $x=\pi/6$, cosine is 1 and $y=-1$, a minimum. Half a period later, $x=2\pi/3$, cosine is -1 and $y=7$, a maximum. The negative outside coefficient reverses which cosine landmark is high.

Evidence and response

Ask for a labeled feature, evidence from a graph or algebra, and an interpretation in units. Check every domain boundary before joining intervals. In technology tasks, collect the window, radian-mode setting, all crossings, a test point in each interval and an algebraic verification; a screenshot alone is insufficient.

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.1.1 Interpret transformed sine and cosine features, including intervals, extrema and frequency.

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

For $f(x) = 2 \sin x - 1$ on $0 \leq x \leq 2\pi$, find zeros, positive and negative intervals, increasing and decreasing intervals, and both extrema. Sketch one full cycle and distinguish sign from direction of change.

Teacher solution and discussion

Zeros occur at $\pi/6$ and $5\pi/6$. The function is positive on $(\pi/6, 5\pi/6)$ and negative on $[0, \pi/6) \cup (5\pi/6, 2\pi]$. It increases on $(0, \pi/2)$ and $(3\pi/2, 2\pi)$, and decreases on $(\pi/2, 3\pi/2)$. The maximum is 1 at $\pi/2$ and minimum -3 at $3\pi/2$. For example, it is positive but decreasing on $(\pi/2, 5\pi/6)$, showing that sign and direction are different features.

Evidence and response

Ask for a labeled feature, evidence from a graph or algebra, and an interpretation in units. Check every domain boundary before joining intervals. In technology tasks, collect the window, radian-mode setting, all crossings, a test point in each interval and an algebraic verification; a screenshot alone is insufficient.

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.F.1.1 Interpret transformed sine and cosine features, including intervals, extrema and frequency.

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 $y = 3 \cos[2(x - \pi/4)] + 1$, give one full-cycle interval starting at $x = \pi/4$. List the maximum, minimum and midline crossings in that cycle, then state the open increasing and decreasing intervals.

Teacher solution and discussion

The period is π , so choose $[\pi/4, 5\pi/4]$. The maxima are $(\pi/4, 4)$ and $(5\pi/4, 4)$; the minimum is $(3\pi/4, -2)$. Midline crossings occur at $x = \pi/2$ and π , both with $y = 1$. The function decreases on $(\pi/4, 3\pi/4)$ and increases on $(3\pi/4, 5\pi/4)$. The quarter-period spacing is $\pi/4$.

Evidence and response

Ask for a labeled feature, evidence from a graph or algebra, and an interpretation in units. Check every domain boundary before joining intervals. In technology tasks, collect the window, radian-mode setting, all crossings, a test point in each interval and an algebraic verification; a screenshot alone is insufficient.

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.1.2 Interpret tangent, cotangent, secant and cosecant features, domains and asymptotes.

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

Analyze $y = \csc x$ on $0 < x < 2\pi$. State excluded inputs, sign intervals, relative extrema and all intervals of increase and decrease. Explain why $\csc x$ has no amplitude even though its vertices are at heights ± 1 .

Teacher solution and discussion

The internal excluded input is π ; 0 and 2π are boundary asymptotes. It is positive on $(0, \pi)$ and negative on $(\pi, 2\pi)$. There is a relative minimum 1 at $\pi/2$ and a relative maximum -1 at $3\pi/2$. It decreases on $(0, \pi/2)$ and $(3\pi/2, 2\pi)$, and increases on $(\pi/2, \pi)$ and $(\pi, 3\pi/2)$. Its range is unbounded both above and below, so half a finite maximum-to-minimum range is not defined; ± 1 are local vertex values, not global bounds.

Evidence and response

Ask for a labeled feature, evidence from a graph or algebra, and an interpretation in units. Check every domain boundary before joining intervals. In technology tasks, collect the window, radian-mode setting, all crossings, a test point in each interval and an algebraic verification; a screenshot alone is insufficient.

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 • T3: PC.F.1.3 Build trigonometric functions from specified features and contextual information.

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 sinusoid is required to have period 8, midline 3, amplitude 2, value 5 at $t=0$ and value 1 at $t=2$. Decide whether all these conditions can hold. Justify your answer rather than forcing a formula.

Teacher solution and discussion

They cannot all hold. Since 5 is the specified maximum, a sinusoid of period 8 reaches its next minimum 4 time units later, not 2. At a quarter-period after a maximum, $t=2$, it must be on the midline $y=3$. For example, $3+2 \cos(\pi t/4)$ meets the first four conditions but gives 3 at $t=2$. The stated minimum at $t=2$ contradicts the required period.

Evidence and response

Ask for a labeled feature, evidence from a graph or algebra, and an interpretation in units. Check every domain boundary before joining intervals. In technology tasks, collect the window, radian-mode setting, all crossings, a test point in each interval and an algebraic verification; a screenshot alone is insufficient.

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 • T4: PC.F.1.4 Solve contextual trigonometric equations and inequalities using algebra and technology.

Optional bank: M24–M27; O24–O27. Select tasks across more than one meeting if needed.

Suggested discussion/work time: 10–15 minutes. Adjust for access and evidence; this is not a speed criterion.

Display student page O24, including its graph when present. Start with the learner's prior evidence. Rebuild one representation with explicit terms and operations, then use a fresh item to check transfer without the prior cue.

Core task

For Model C, use the four $C=3.6$ crossings to find all times when $C(t)>3.6$ on $0\leq t\leq 2\pi$ hours. Estimate the total duration to three decimals and verify which intervals qualify by testing points.

Teacher solution and discussion

Let $r_1\approx 0.112941623$, $r_2\approx 1.091453792$, $r_3\approx 2.050138862$ and $r_4\approx 3.028651031$. The graph is above 3.6 on $(r_1, r_2) \cup (r_3, r_4)$. For example $t=\pi/6$ and $5\pi/6$ give $C=3.75$, while $t=\pi/2$ gives $C=3.5$ and lies in the gap. The total duration is $(r_2-r_1)+(r_4-r_3)\approx 1.957$ hours, using unrounded crossings. Both domain endpoints give $C=3.5$ and do not qualify.

Evidence and response

Ask for a labeled feature, evidence from a graph or algebra, and an interpretation in units. Check every domain boundary before joining intervals. In technology tasks, collect the window, radian-mode setting, all crossings, a test point in each interval and an algebraic verification; a screenshot alone is insufficient.

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 • T4: PC.F.1.4 Solve contextual trigonometric equations and inequalities using algebra and technology.

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

A line-of-sight distance is $d(\theta) = 10 \sec \theta$ meters for $0 \leq \theta \leq \pi/3$. Use a graphing tool in radian mode to find when $d \leq 15$. Give the exact boundary angle and its decimal to three places, then justify the interval and endpoints algebraically.

Teacher solution and discussion

Graph d and $y=15$ with $0 \leq \theta \leq \pi/3$ and $0 \leq d \leq 22$. The crossing is $\theta = \arccos(2/3) \approx 0.841$ radians. Because $\cos \theta$ is positive and decreasing on this domain, d increases from 10 to 20. Algebraically $10/\cos \theta \leq 15$ is equivalent to $\cos \theta \geq 2/3$, so the solution is $0 \leq \theta \leq \arccos(2/3)$. Include 0 because $d(0)=10$ and include the crossing because equality is allowed; the domain endpoint $\pi/3$ gives 20 and is excluded.

Evidence and response

Ask for a labeled feature, evidence from a graph or algebra, and an interpretation in units. Check every domain boundary before joining intervals. In technology tasks, collect the window, radian-mode setting, all crossings, a test point in each interval and an algebraic verification; a screenshot alone is insufficient.

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****For $y = -3 \sin[2(x - \pi/4)] + 1$, which feature list is correct?**

- A. Amplitude -3 ; period π ; midline $y=1$; shift right $\pi/4$.
- B. Amplitude 3 ; period π ; midline $y=1$; shift right $\pi/4$.
- C. Amplitude 3 ; period 2π ; midline $y=1$; shift right $\pi/4$.
- D. Amplitude 3 ; period π ; midline $y=-1$; shift left $\pi/4$.

Reasoning: _____

M02 | Warm-up | T2**Which is the domain of $y = \tan x$?**

- A. All real x except $x = \pi/2 + k\pi$, for integer k .
- B. All real x .
- C. All real x except $x = k\pi$, for integer k .
- D. Only $-\pi/2 < x < \pi/2$.

Reasoning: _____

WARM-UP

001 • Show your reasoning

T1: PC.F.1.1 Interpret transformed sine and cosine features, including intervals, extrema and frequency.

Analyze $y = -4 \cos[2(x - \pi/6)] + 3$. State domain, amplitude, midline, period, frequency in cycles per unit, range and a direct phase shift. Identify one minimum and the next maximum.

Representation / calculation

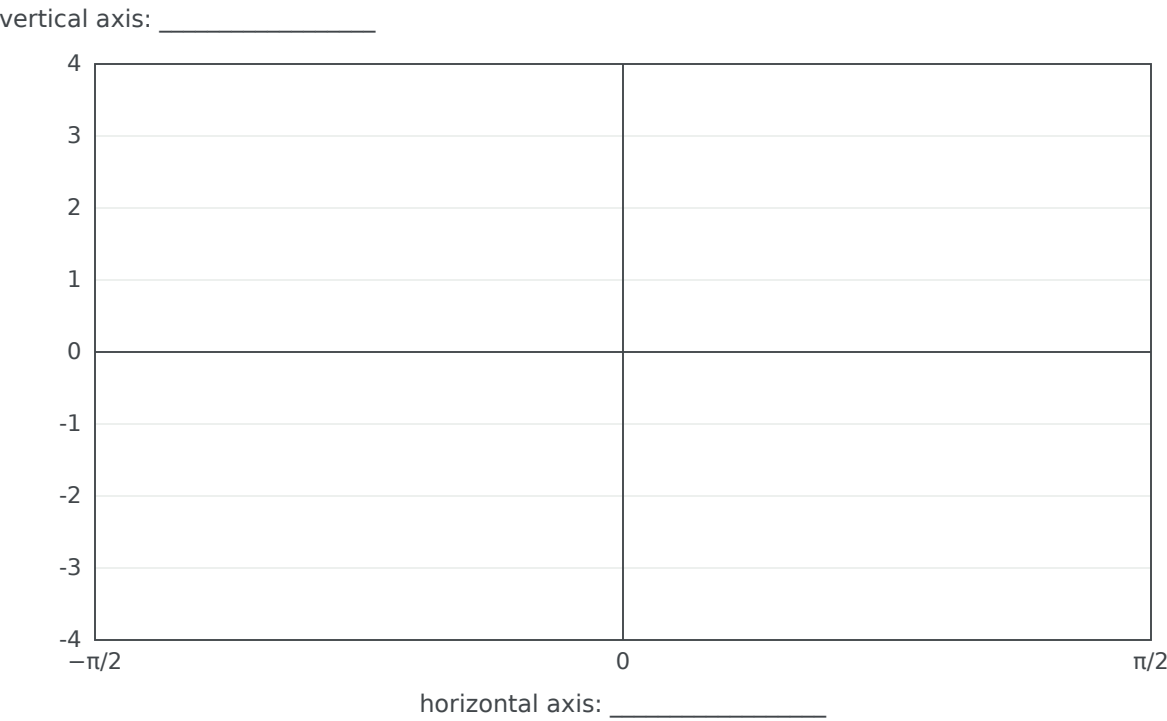
Explanation / check

WARM-UP

002 • Show your reasoning

T2: PC.F.1.2 Interpret tangent, cotangent, secant and cosecant features, domains and asymptotes.

For $y=\tan x$, describe domain, fundamental period, frequency, zeros, signs and monotonicity on the central branch. Sketch that branch with its asymptotes and explain why it has no relative extremum.



Explanation and check

WORKED TEACHER KEYS

M01 / M02

M01 • T1: PC.F.1.1 Interpret transformed sine and cosine features, including intervals, extrema and frequency.

Answer: B. Amplitude 3; period π ; midline $y=1$; shift right $\pi/4$.

Read $|A|=3$, $P=2\pi/2=\pi$, $D=1$ and $C=\pi/4$ after factoring the argument.

Check each alternative

- A. Amplitude is a nonnegative distance, so it is $|-3|$.
- B. Correct. Read $|A|=3$, $P=2\pi/2=\pi$, $D=1$ and $C=\pi/4$ after factoring the argument.
- C. The argument coefficient 2 halves the usual sine period.
- D. The outside $+1$ raises the midline, and $x-\pi/4$ shifts right.

M02 • T2: PC.F.1.2 Interpret tangent, cotangent, secant and cosecant features, domains and asymptotes.

Answer: A. All real x except $x=\pi/2+k\pi$, for integer k .

$\tan x = \sin x / \cos x$ requires $\cos x \neq 0$, excluding $\pi/2+k\pi$.

Check each alternative

- A. Correct. $\tan x = \sin x / \cos x$ requires $\cos x \neq 0$, excluding $\pi/2+k\pi$.
- B. Cosine is zero at some real inputs, so the quotient is not always defined.
- C. Those are zeros of sine, not zeros of the tangent denominator.
- D. That is one branch, not the complete periodic domain.

WORKED TEACHER KEYS

001**001 • T1: PC.F.1.1 Interpret transformed sine and cosine features, including intervals, extrema and frequency.**

The domain is all real x . Amplitude is 4, midline $y=3$, period π and frequency $1/\pi$. The range is $[-1, 7]$, and the factored form gives a shift right $\pi/6$. At $x=\pi/6$, cosine is 1 and $y=-1$, a minimum. Half a period later, $x=2\pi/3$, cosine is -1 and $y=7$, a maximum. The negative outside coefficient reverses which cosine landmark is high.

Evidence to assess

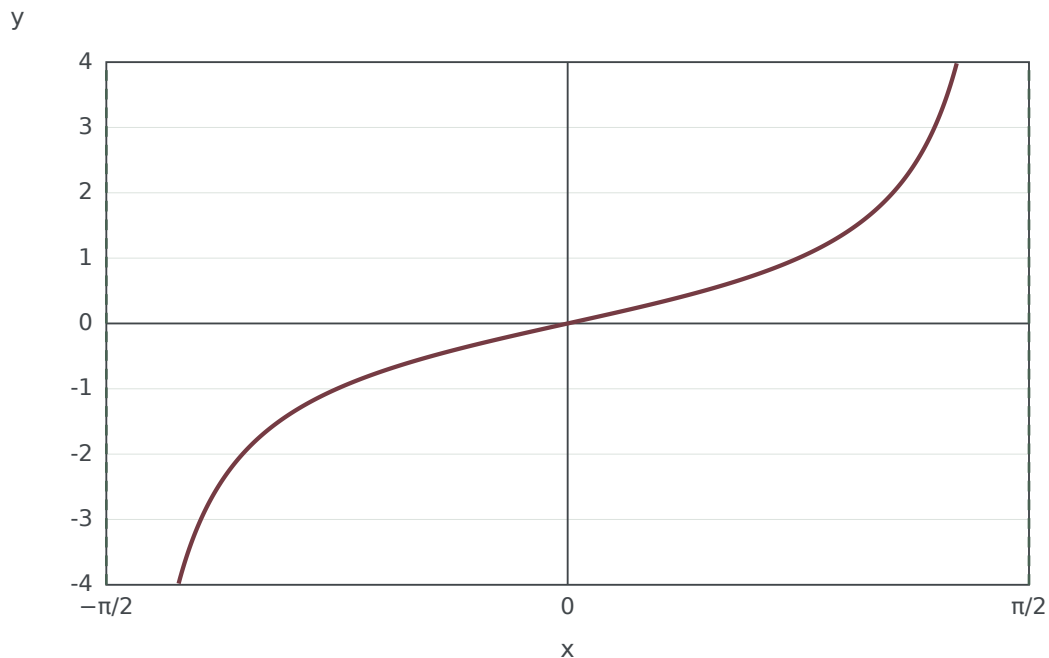
Full evidence: All seven features with the frequency convention, two correct extrema and the effect of reflection. Partial credit: preserve and score a valid intermediate representation or justified step separately from the final accuracy.

WORKED TEACHER KEYS

002

002 • T2: PC.F.1.2 Interpret tangent, cotangent, secant and cosecant features, domains and asymptotes.

The domain excludes $\pi/2 + k\pi$. Period is π and frequency $1/\pi$. Zeros occur at $k\pi$. On $(-\pi/2, \pi/2)$, tangent is negative for $x < 0$, zero at 0 and positive for $x > 0$; it increases throughout. The endpoints are vertical asymptotes. The branch passes through $(-\pi/4, -1)$, $(0, 0)$, $(\pi/4, 1)$ without a turn, so there is no relative extremum. Translate this pattern by $k\pi$.

**Evidence to assess**

Full evidence: Domain and periodic features, central-branch sign and direction intervals, asymptotes and a matching sketch without a false turning point. Partial credit: preserve and score a valid intermediate representation or justified step separately from the final accuracy.