Sets & Steps
Math Practice & Worked Solutions

Precalculus

Polar Symmetry, Features & Rates | 3-Topic Precalculus Bundle

3-topic bundle | 288 problems | Four activity formats

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01 Polar Symmetry and Curve Tracing

View individual product and its full preview

02 Features of Polar Equations

View individual product and its full preview

03 Polar Rates of Change and Radial Motion

View individual product and its full preview

In every topic

Answer Bank Challenge	24 tasks
Grid Rounds	24 tasks
Match & Move	24 cards
Error Analysis & Strategy	24 tasks
Quick Answer Key and Full Worked Solutions	included
Teacher / Parent Use Guide and Terms of Use	included

Product previews

The following preview pages show the cover, all four activity formats, and worked examples for each included resource, in the listed order.

24 PDFs and 3 READMEs; 347 buyer PDF pages across the 3 products.

Preview pages are not included in the buyer page count. Check the list against resources you already own.

This is a fixed collection of the listed products. Purchase includes the existing individual resource files. To open a product's online preview, follow its title link and select View Preview.

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Sets & Steps
Math Practice & Worked Solutions

AP Precalculus

Polar Symmetry and Curve Tracing

Polar Symmetry and Curve Tracing | APPC-U03-P26

96 problems · Four activity formats

Topic focus

Across 96 tasks this topic asks for sufficient interval and retrace explanation, symmetry conclusion, once-through subinterval and retrace explanation, pole and nonpole multiplicities, pole multiplicity and nonpole verdict and partial/full/retraced judgment.

8 PDFs and a README; 156 buyer pages.

The following pages use the same questions, given data, and notation as the final files. Question/card serial numbers and internal IDs are omitted in this preview only. Table values and matching responses are retained. Full answer keys are not included.

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AP Precalculus

Polar Symmetry and Curve Tracing

Name: _____ **Date:** _____ **Class:** _____

Answer each question and record the matching bank letter. Give exact values. Give the whole requested response, including any reasoning the question asks for.

On $r = 2\sin(3\theta)$, show that $\theta = \frac{\pi}{6}$ and $\theta = 7\frac{\pi}{6}$ represent the same petal tip and give its Cartesian coordinates.

Solve the problem, then match the entire requested response to one unused entry in the Answer Bank.

Given θ	Given r
$\frac{\pi}{6}$	2
$7\frac{\pi}{6}$	-2

Condition or evidence	Supplied value
Original polar rule	$r = 2\sin(3\theta)$
Given target point	distance 2 on ray $\frac{\pi}{6}$

Bank label: _____

How many times does $r = 2 + 2\cos\theta$ visit the pole on $0 \le \theta < 2\pi$? Distinguish that count from the closed-curve endpoint convention.

Solve the problem, then match the entire requested response to one unused entry in the Answer Bank.

Condition or evidence	Supplied value
Original polar rule	$r = 2 + 2\cos\theta$
Given equation for zero radius	$\cos\theta = -1$

Bank label: _____

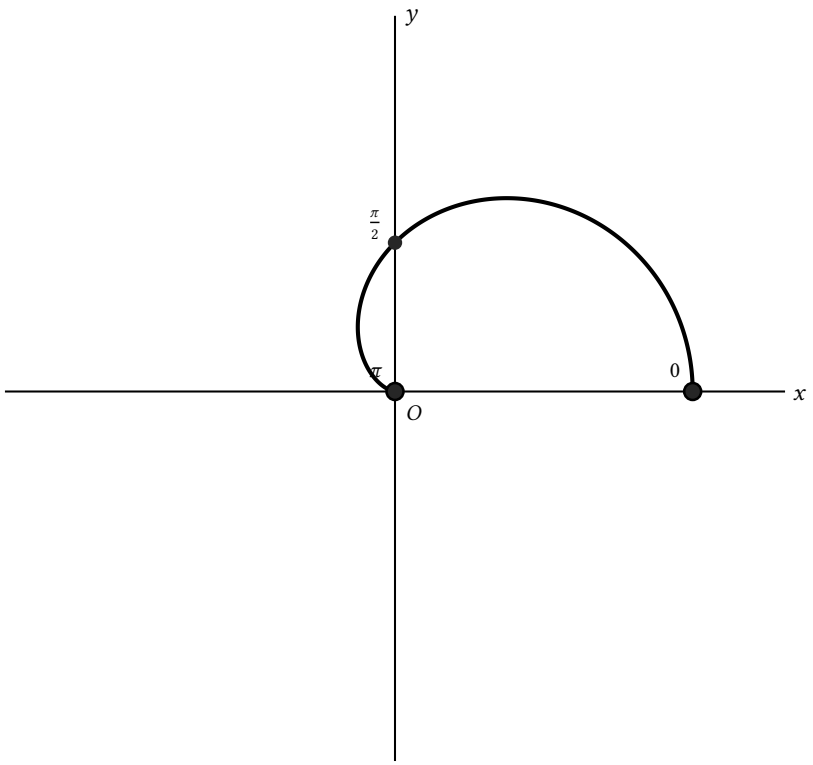
AP Precalculus

Polar Symmetry and Curve Tracing

Name: _____ **Date:** _____ **Class:** _____

Answer each question and show your reasoning in the workspace. Give exact values rather than decimals unless the question supplies a decimal. Give the whole requested response, including any reasoning the question asks for.

For $r = 1 + \cos\theta$ on $0 \le \theta \le \pi$, describe the direction of travel through the three labeled anchors as θ increases.



Given parameter	Given point or location
0	$(2, 0)$
$\frac{\pi}{2}$	$(0, 1)$
π	pole

Condition or evidence	Supplied value
Original polar rule	$r = 1 + \cos\theta$

AP Precalculus

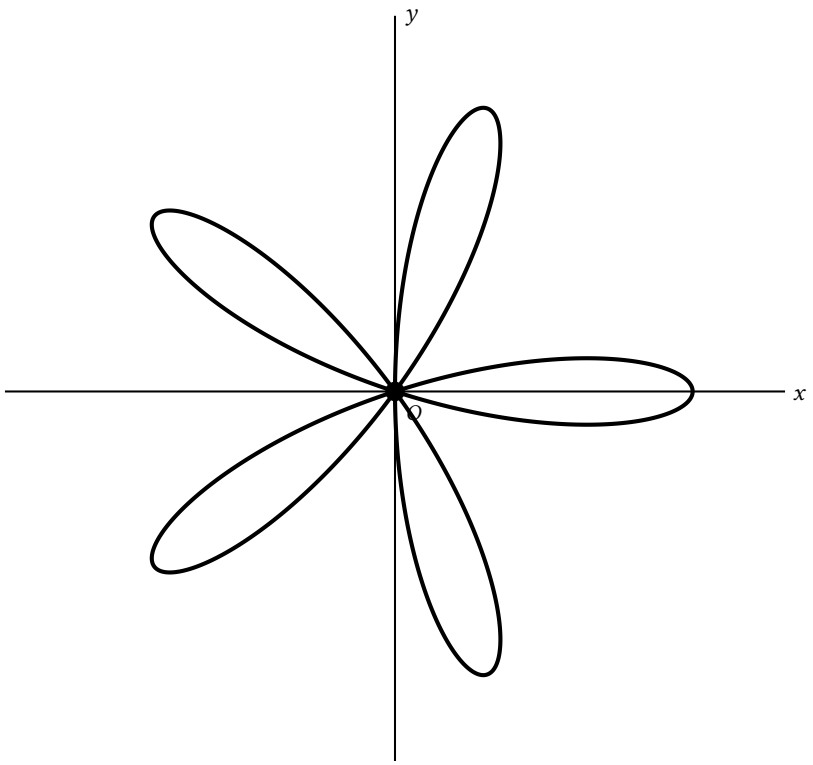
Polar Symmetry and Curve Tracing

Name: _____ **Date:** _____ **Class:** _____

Begin at START. Answer the card, then find the matching final answer at the top of another card. Use the recording sheet for your reasoning. Visit each card once and continue to FINISH.

START

Determine whether $-\frac{\pi}{2} \le \theta \le \frac{\pi}{2}$ is sufficient to trace every petal of $r = \cos(5\theta)$ once. Justify with a half-turn correspondence rather than a memorized rule.



Condition or evidence	Supplied value
Half turn relation	$r(\theta + \pi) = -r(\theta)$
Interval length	π
Original polar rule	$r = \cos(5\theta)$

Your response: _____

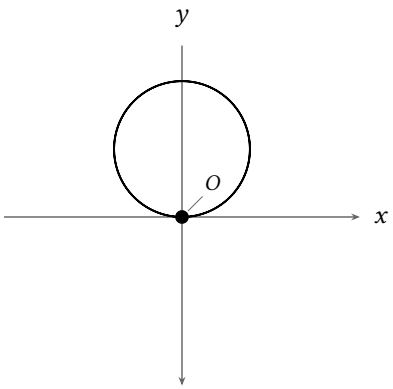
AP Precalculus

Polar Symmetry and Curve Tracing

Name: _____ **Date:** _____ **Class:** _____

Evaluate the supplied statement or method. Say whether it is correct, repair it if it is not, and verify the result exactly. Not every prompt contains an error.

A student says $r = \sin\theta$ needs all of $[0, 2\pi]$ for one trace because $\sin\theta$ has period 2π. Repair the claim using signed-radius equivalence.



Condition or evidence	Supplied value
Half turn relation	$r(\theta + \pi) = -r(\theta)$
Original polar rule	$r = \sin\theta$
Student claim to examine	A full 2π parameter interval is required because the radius has period 2π.

Polar Symmetry and Curve Tracing

Full Worked Solutions - excerpt

Worked example

Problem. Which parameters repeat the closing point of $r = 4$ on the closed interval $0 \le \theta \le 2\pi$?

Solve the problem, then match the entire requested response to one unused entry in the Answer Bank.

Condition or evidence	Supplied value
Given common-point reference	$(4, 0)$
Original polar rule	$r = 4$

Answer. $\theta = 0$ and $\theta = 2\pi$ both give $(4, 0)$.

Explanation and check.

The radius is 4 at both coterminal endpoint angles, so the two polar pairs locate the same point.

Worked example

Problem. A polar table contains $(\theta, r) = (\frac{\pi}{3}, 2)$ and $(4\frac{\pi}{3}, -2)$. Do the rows locate the same point? Give the coordinate.

Solve the card and move only to the card whose incoming header matches the entire requested response.

θ	Given r
$\frac{\pi}{3}$	2
$4\frac{\pi}{3}$	-2

Answer. Yes; both locate $(1, \sqrt{3})$.

Explanation and check.

The angles differ by π and the radii are opposites, so the polar pairs are equivalent. Converting the first gives $(2\cos(\frac{\pi}{3}), 2\sin(\frac{\pi}{3})) = (1, \sqrt{3})$.

Sets & Steps
Math Practice & Worked Solutions

AP Precalculus

Features of Polar Equations

Features of Polar Equations | APPC-U03-P27

96 problems · Four activity formats

Topic focus

Across 96 tasks this topic asks for minimum distance and locations, distance and parameter, ordered exact parameter list, closest point and distance, distance and location and distinct coordinate set.

8 PDFs and a README; 83 buyer pages.

The following pages use the same questions, given data, and notation as the final files. Question/card serial numbers and internal IDs are omitted in this preview only. Table values and matching responses are retained. Full answer keys are not included.

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AP Precalculus

Features of Polar Equations

Name: _____ **Date:** _____ **Class:** _____

Answer each question and record the matching bank letter. Give exact values. A value without its unit is not a complete answer.

In the family $r = a + \cos\theta$, choose a so that the curve reaches the pole at $\theta = \pi$. Bank label: _____	For $r = a + 2\sin\theta$ with $a \geq 2$, determine a if the greatest distance from the pole is 5. Bank label: _____
Determine a in $r = a + \sin\theta$ if every radius is negative and the closest distance to the pole is 2. Bank label: _____	At what parameter does $r = 5\theta$ reach the pole on $-1 \leq \theta \leq 1$? Bank label: _____

AP Precalculus

Features of Polar Equations

Name: _____ **Date:** _____ **Class:** _____

Answer each question and show your reasoning in the workspace. Give exact values rather than decimals unless the question supplies a decimal. A value without its unit is not a complete answer.

Find every θ in $0 \le \theta \le \pi$ for which $r = 2\sin\theta$ is zero, and name the plane point reached.

AP Precalculus

Features of Polar Equations

Name: _____ **Date:** _____ **Class:** _____

Begin at START. Answer the card, then find the matching final answer at the top of another card. Use the recording sheet for your reasoning. Visit each card once and continue to FINISH.

START For $0 \le \varphi < 2\pi$, the curve $r = 3 + 3\cos(\theta - \varphi)$ has its cusp at the pole when $\theta = 5\frac{\pi}{6}$. Find φ. Your response: _____	**Incoming:** $\varphi = 11\frac{\pi}{6}$. Choose a in $r = 2 + a\cos\theta$ so that $\theta = 0$ is a pole parameter. Verify the resulting zero. Your response: _____
Incoming: -2 Find a if $r = a + 4\cos\theta$ must pass through the pole at $\theta = 2\frac{\pi}{3}$. Your response: _____	**Incoming:** a = 2. For k>0, the curve r=k(1-cos θ) has farthest distance 10. Determine k. Your response: _____

AP Precalculus

Features of Polar Equations

Name: _____ **Date:** _____ **Class:** _____

Evaluate the supplied statement or method. Say whether it is correct, repair it if it is not, and verify the result exactly. Not every prompt contains an error.

A table row gives $(\theta, r) = (\frac{\pi}{4}, -7)$, and a student reports a distance of -7. Correct both the distance and the plotted direction.

A student finds seven zero parameters for $r = \sin(3\theta)$ on $0 \le \theta \le 2\pi$ and reports seven different poles. Correct the feature count.

Features of Polar Equations

Full Worked Solutions - excerpt

Worked example

Problem. Choose a in $r = 2 + a\cos\theta$ so that $\theta = 0$ is a pole parameter. Verify the resulting zero.

Answer. -2

Explanation and check.

At $\theta = 0$ the radius is $2 + a$. Setting it to zero gives $a = -2$, and substitution yields $r(0) = 2 - 2 = 0$.

Worked example

Problem. For k>0, the curve r=k(1-cos θ) has farthest distance 10. Determine k.

Answer. k = 5.

Explanation and check.

The factor $1 - \cos\theta$ is largest at $\theta = \pi$, where it equals 2. Thus the farthest distance is $2k$, and $2k = 10$ gives $k = 5$.

Sets & Steps
Math Practice & Worked Solutions

AP Precalculus

Polar Rates of Change and Radial Motion

Polar Rates of Change and Radial Motion | APPC-U03-P28

96 problems · Four activity formats

Topic focus

Across 96 tasks this topic asks for supported or undetermined with alternative, estimated radius, exact signed rate and interpretation, local closest or farthest, local feature and inward and outward intervals.

8 PDFs and a README; 108 buyer pages.

The following pages use the same questions, given data, and notation as the final files. Question/card serial numbers and internal IDs are omitted in this preview only. Table values and matching responses are retained. Full answer keys are not included.

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AP Precalculus

Polar Rates of Change and Radial Motion

Name: _____ **Date:** _____ **Class:** _____

Answer each question and record the matching bank letter. Give exact values. A value without its unit is not a complete answer.

The average signed-radius rate from $\theta = 0$ to $\theta = 2$ is 3 units per radian, and $r(0) = -1$. Recover $r(2)$. Bank label: _____	The average radial rate over $2 \le \theta \le 4$ is -3, and $r(4) = 1$. Use the secant model to estimate $r(3)$. Bank label: _____
The average radial rate from $\theta = \frac{1}{2}$ to $\theta = \theta_2$ is -4. If $r(\frac{1}{2}) = 6$ and $r(\theta_2) = 2$, find θ_2. Bank label: _____	The average signed-radius rate from 30° to 90° is 2 units per radian, and $r(30^\circ) = 1$. Find $r(90^\circ)$. Bank label: _____

AP Precalculus

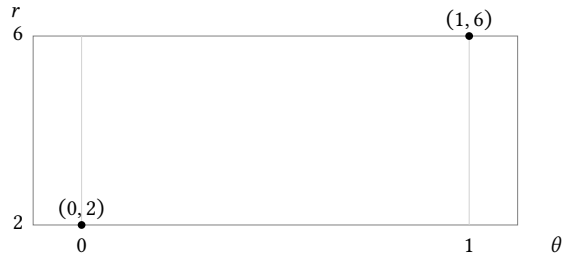
Polar Rates of Change and Radial Motion

Name: _____ **Date:** _____ **Class:** _____

Answer each question and show your reasoning in the workspace. Give exact values rather than decimals unless the question supplies a decimal. A value without its unit is not a complete answer.

Throughout an angle interval, r is negative and increases from -7 toward -2. Is the point moving inward or outward relative to the pole?

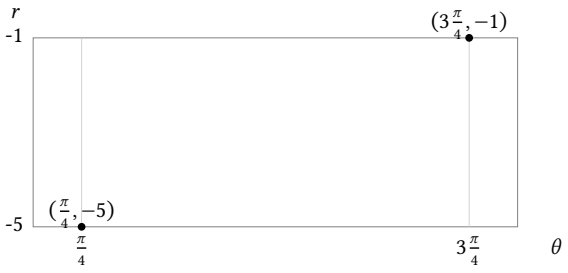
Using the average rate between the two table rows, estimate r at $\theta = \frac{1}{2}$. Is the result necessarily exact?



0	2
1	6

Near $\theta = a$, a radius graph stays positive and has a local minimum $r = 2$. What distance feature does the polar point have at a?

Compute the average signed-radius rate from $\theta = \frac{\pi}{4}$, where $r = -5$, to $\theta = 3\frac{\pi}{4}$, where $r = -1$.



$\frac{\pi}{4}$	-5
$3\frac{\pi}{4}$	-1

AP Precalculus

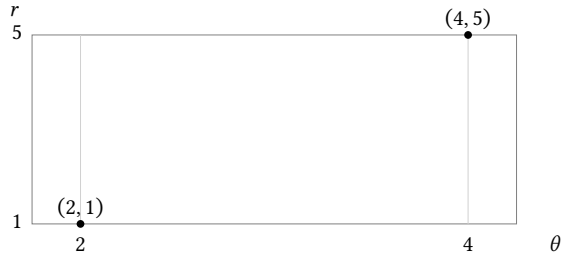
Polar Rates of Change and Radial Motion

Name: _____ **Date:** _____ **Class:** _____

Begin at START. Answer the card, then find the matching final answer at the top of another card. Use the recording sheet for your reasoning. Visit each card once and continue to FINISH.

Incoming: $r(90^\circ) \approx 4$.

A table gives $r(2) = 1$ and $r(4) = 5$. Use the average rate to estimate $r(3)$, and say whether the estimate must be exact.



2	1
4	5

Your response: _____

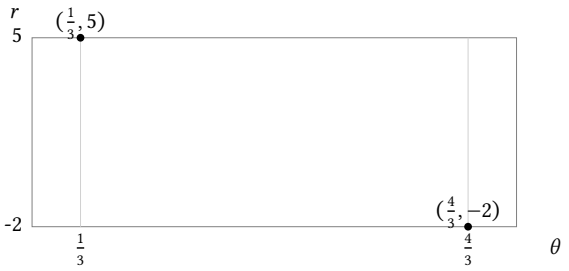
Incoming: Signed-radius rate 2; distance rate $\frac{4}{3}$ radial units per radian.

For $r = 2^\theta$, find the average radial rate from $\theta = 0$ to $\theta = 1$.

Your response: _____

Incoming: Both rates are -3 radial units per radian.

Find the average radial rate from $r(\frac{1}{3}) = 5$ to $r(\frac{4}{3}) = -2$.

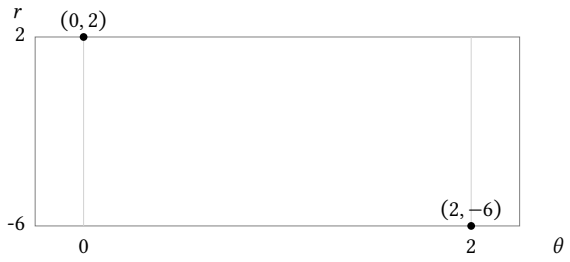


$\frac{1}{3}$	5
$\frac{4}{3}$	-2

Your response: _____

Incoming: The estimate is 10 and the actual radius lies in $[9.5, 10.5]$.

A diagram labels $r = 2$ at $\theta = 0$ and $r = -6$ at $\theta = 2$. Find the average radial and distance rates.



0	2
2	-6

Your response: _____

AP Precalculus

Polar Rates of Change and Radial Motion

Name: _____ **Date:** _____ **Class:** _____

Evaluate the supplied statement or method. Say whether it is correct, repair it if it is not, and verify the result exactly. Not every prompt contains an error.

A student computes $\frac{5-2}{90-30} = \frac{1}{20}$ and labels it radial units per radian. Repair the interpretation.

Required response

30°	2
90°	5

Polar Rates of Change and Radial Motion

Full Worked Solutions - excerpt

Worked example

Problem. A signed radius rises from 2 to 12 at average rate 5. What is the angular interval width?

Answer. $\theta_2 - \theta_1 = 2$ radians.

Explanation and check.

The radius change is 10. Dividing change by rate gives a width of 2 radians.

Worked example

Problem. For $r = 2^{\theta}$, find the average radial rate from $\theta = 0$ to $\theta = 1$.

Answer. 1 radial unit per radian.

Explanation and check.

The radius changes from 1 to 2 over one radian, so the secant quotient is 1.