

Precalculus
Parametric Motion, Rates & Circles | 3-Topic Precalculus Bundle

3-topic bundle | 288 problems | Four activity formats

01 Parametric Motion and Intersections

View individual product and its full preview

02 Average Rates and Speed in Parametric Motion

View individual product and its full preview

03 Parametric Circles

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; 429 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.

AP Precalculus
Parametric Motion and Intersections

Parametric Motion and Intersections | APPC-U04-P03

96 problems · Four activity formats

01	Answer Bank Challenge	24 tasks
02	Grid Rounds	24 tasks
03	Match & Move	24 cards
04	Error Analysis & Strategy	24 tasks
05	Quick Answer Key	96 answers
06	Full Worked Solutions	96 solutions
07	Teacher / Parent Use Guide	included
08	Terms of Use & License	included

Topic focus

Across 96 tasks this topic asks for all extrema with times and points, rightmost and highest positions, feasible interval, paired rules, paired model and all times and positions.

8 PDFs and a README; 149 buyer pages.

AP Precalculus

Parametric Motion
and Intersections

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.

Do the robots collide during the observation window?
Solve the problem, then match the entire requested response to one unused entry in the Answer Bank.

Condition or evidence	Supplied value
Original time range or clock definition	$0 \leq t \leq 3$ seconds
Robot A	X t Y $2t$
Robot B	X $6 - 2t$ Y $8 - 2t$

Bank label: _____

AP Precalculus

Parametric Motion
and Intersections

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: At $t = 4$ seconds, at $(4, 3)$. When is the object inside the corridor and at nonnegative height? Solve the card, use the complete requested response as the outgoing match, and move to the unique card whose incoming header matches it; continue until FINISH. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Condition or evidence</th><th style="width: 50%;">Supplied value</th></tr> </thead> <tbody> <tr> <td rowspan="2">Conditions</td><td>$-2 \leq x \leq 4$</td></tr> <tr> <td>$y \geq 0$</td></tr> <tr> <td>Original time range or clock definition</td><td>$0 \leq t \leq 8$ seconds</td></tr> <tr> <td>Given $x(t)$</td><td>$x = t - 3$ meters</td></tr> <tr> <td>Given $y(t)$</td><td>$y = 12 - 2t$ meters</td></tr> </tbody> </table> Your response: _____	Condition or evidence	Supplied value	Conditions	$-2 \leq x \leq 4$	$y \geq 0$	Original time range or clock definition	$0 \leq t \leq 8$ seconds	Given $x(t)$	$x = t - 3$ meters	Given $y(t)$	$y = 12 - 2t$ meters	Incoming: Leftmost and highest occur at $t = 0, 4$, both at $(0, 3)$. Rightmost and lowest occur at $t = 2$ at $(4, -1)$. When does the object cross the x-axis? Solve the card, use the complete requested response as the outgoing match, and move to the unique card whose incoming header matches it; continue until FINISH. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Condition or evidence</th><th style="width: 50%;">Supplied value</th></tr> </thead> <tbody> <tr> <td>Original time range or clock definition</td><td>$0 \leq t \leq 4$ seconds</td></tr> <tr> <td>Given $x(t)$</td><td>$x = \frac{1}{t+2}$ meters</td></tr> <tr> <td>Given $y(t)$</td><td>$y = t - 1$ meters</td></tr> </tbody> </table> Your response: _____	Condition or evidence	Supplied value	Original time range or clock definition	$0 \leq t \leq 4$ seconds	Given $x(t)$	$x = \frac{1}{t+2}$ meters	Given $y(t)$	$y = t - 1$ meters		
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Incoming: $t \in [0, 2] \cup [4, 5]$. Find the position at $t = 3$ seconds. Solve the card, use the complete requested response as the outgoing match, and move to the unique card whose incoming header matches it; continue until FINISH. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Condition or evidence</th><th style="width: 50%;">Supplied value</th></tr> </thead> <tbody> <tr> <td>Original time range or clock definition</td><td>$0 \leq t \leq 6$ seconds</td></tr> <tr> <td>Time to evaluate</td><td>3</td></tr> <tr> <td>Given $x(t)$</td><td>$x = t - 4$ meters</td></tr> <tr> <td>Given $y(t)$</td><td>$y = 2t + 1$ meters</td></tr> </tbody> </table> Your response: _____	Condition or evidence	Supplied value	Original time range or clock definition	$0 \leq t \leq 6$ seconds	Time to evaluate	3	Given $x(t)$	$x = t - 4$ meters	Given $y(t)$	$y = 2t + 1$ meters	Incoming: At $t = 1$ the position is $(0, 0)$, and at the included endpoint $t = 3$ it is $(0, 2)$. When is the object both on or right of the y-axis and at nonnegative height? Solve the card, use the complete requested response as the outgoing match, and move to the unique card whose incoming header matches it; continue until FINISH. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Condition or evidence</th><th style="width: 50%;">Supplied value</th></tr> </thead> <tbody> <tr> <td rowspan="2">Conditions</td><td>$x \geq 0$</td></tr> <tr> <td>$y \geq 0$</td></tr> <tr> <td>Original time range or clock definition</td><td>$0 \leq t \leq 6$ seconds</td></tr> <tr> <td>Given $x(t)$</td><td>$x = t^2 - 1$ meters</td></tr> <tr> <td>Given $y(t)$</td><td>$y = 5 - t$ meters</td></tr> </tbody> </table> Your response: _____	Condition or evidence	Supplied value	Conditions	$x \geq 0$	$y \geq 0$	Original time range or clock definition	$0 \leq t \leq 6$ seconds	Given $x(t)$	$x = t^2 - 1$ meters	Given $y(t)$	$y = 5 - t$ meters
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AP Precalculus

Parametric Motion
and Intersections

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.

Repair the student's claim using the two supplied times.

Identify the error or first invalid step, give the corrected result, and state a brief mathematical reason.

Condition or evidence	Supplied value
Comparison times	
	2
	3
Original time range or clock definition	$0 \leq t \leq 6$ seconds
Student claim to examine	At $t = 2$ the cart is moving left because $x(2) < 0$.
Given $x(t)$	$x = -5 + t$ meters
Given $y(t)$	$y = 2$ meters

A student claims the motion never reaches the y -axis during $0 \leq t \leq 3$ because the event would occur only after the interior of the interval. Identify the error, then give the correct event time and position.

Identify the error or first invalid step, give the corrected result, and state a brief mathematical reason.

Condition or evidence	Supplied value
Original time range or clock definition	$0 \leq t \leq 3$ seconds
Event	y -axis means $x = 0$
Given $x(t)$	$x = 3 - t$ meters
Given $y(t)$	$y = t^2 + 1$ meters

Parametric Motion and Intersections

Full Worked Solutions - excerpt

Worked example

Problem. When does the object cross the y -axis?

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

Condition or evidence	Supplied value
Original time range or clock definition	$0 \leq t \leq 4$ seconds
Given $x(t)$	$x = 3t - 6$ meters
Given $y(t)$	$y = t^2$ meters

Answer. At $t = 2$ seconds, at $(0, 4)$ meters.

Explanation and check.

Set $x = 0$ to get $t = 2$, then evaluate y at that same time.

Worked example

Problem. List every ground event in the time window and the position at each one.

Show a complete response in the numbered workspace, preserving requested exactness, units, interval endpoints, and justification.

Condition or evidence	Supplied value
Original time range or clock definition	$0 \leq t \leq 5$ seconds
Given $x(t)$	$x = 2t - 3$ meters
Given $y(t)$	$y = (t - 1)(t - 4)$ meters

Answer. At $t = 1$ the position is $(-1, 0)$, and at $t = 4$ it is $(5, 0)$.

Explanation and check.

The height factors vanish at $t = 1$ and $t = 4$; the horizontal coordinate must be evaluated separately at each event time.

AP Precalculus
Average Rates and Speed in Parametric Motion

Average Rates and Speed in Parametric Motion | APPC-U04-P04

96 problems · Four activity formats

01	Answer Bank Challenge	24 tasks
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Topic focus

Across 96 tasks this topic asks for classification and slope, classification, slope, and orientation, slope status, slope status and direction, two ordered pairs and two rate pairs and scale factor.

8 PDFs and a README; 141 buyer pages.

AP Precalculus

Average Rates and Speed
in Parametric 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.

Find the average horizontal and vertical rates over the interval.

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

t	x	y
1	2	-1
3	8	5

Condition or evidence	Supplied value
Original interval or clock definition	$1 \leq t \leq 3$ seconds
Units	meters

Bank label: _____

AP Precalculus

Average Rates and Speed
in Parametric 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.

Find average speed and average-velocity magnitude.

Show a complete response in the numbered workspace, preserving requested exactness, units, interval endpoints, and justification.

t	x	y
0	0	0
2	8	0
5	3	0

Condition or evidence	Supplied value
Original interval or clock definition	$0 \leq t \leq 5$ seconds
Segments	straight between rows
Units	meters

Find the endpoint after the stated interval.

Show a complete response in the numbered workspace, preserving requested exactness, units, interval endpoints, and justification.

Condition or evidence	Supplied value
Given component averages	−4 5
Original interval or clock definition	three-parameter-unit interval
Start	8 −1

Compute both exact average coordinate rates.

Show a complete response in the numbered workspace, preserving requested exactness, units, interval endpoints, and justification.

Condition or evidence	Supplied value
Original interval or clock definition	$3 \leq t \leq 8$ seconds
X rule	$x = \sqrt{t+1}$ meters
Y rule	$y = \frac{1}{t}$ meters

Determine the endpoint-secant slope from the exact rates.

Show a complete response in the numbered workspace, preserving requested exactness, units, interval endpoints, and justification.

Condition or evidence	Supplied value
Given average x-rate	$\frac{1}{3}$
Given average y-rate	0
Original interval or clock definition	common nonzero interval

AP Precalculus

Average Rates and Speed
in Parametric 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: Average speed 2 meters per second; average-velocity magnitude $\frac{1}{2}$ meter per second.

Reconstruct the initial position that is compatible with the endpoint and both average rates.

Solve the card, use the complete requested response as the outgoing match, and move to the unique card whose incoming header matches it; continue until FINISH.

Condition or evidence	Supplied value
Given component averages	-2
	3
Original interval or clock definition	four-second observation window
End	5
	8

Your response: _____

AP Precalculus

Average Rates and Speed
in Parametric 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.

Diagnose and repair the student's calculation.

Identify the error or first invalid step, give the corrected result, and state a brief mathematical reason.

Condition or evidence	Supplied value
Original interval or clock definition	$2 \leq t \leq 5$ seconds
End point	7 11
Start point	1 2
Student claim to examine	The average vertical rate is $\frac{\Delta y}{\Delta x} = \frac{9}{6} = \frac{3}{2}$ meters per second.

A student claims: "The endpoint displacement is right and down, so the object moves right and down throughout the sampled interval." Diagnose the first invalid step or assumption, give the corrected conclusion, and justify the correction. Then complete the stated task: Use all rows, not just the endpoints, to describe net direction and any observed reversals.

Identify the error or first invalid step, give the corrected result, and state a brief mathematical reason.

t	x	y	Condition or evidence	Supplied value
0	-2	6	Original interval or clock definition	$0 \leq t \leq 4$ seconds
1	-5	4	Student claim to examine	The endpoint displacement is right and down, so the object moves right and down throughout the sampled interval.
3	-1	4		
4	2	1		

Average Rates and Speed in Parametric Motion

Full Worked Solutions - excerpt

Worked example

Problem. Determine the endpoint-secant slope from the exact rates.

Show a complete response in the numbered workspace, preserving requested exactness, units, interval endpoints, and justification.

Condition or evidence	Supplied value
Given average x -rate	$\frac{1}{3}$
Given average y -rate	0
Original interval or clock definition	common nonzero interval

Answer. 0

Explanation and check.

The nonzero horizontal rate permits division, and 0 divided by $\frac{1}{3}$ is 0.

Worked example

Problem. Determine the two finite coordinate rates across the entire parameter interval.

Solve the card, use the complete requested response as the outgoing match, and move to the unique card whose incoming header matches it; continue until FINISH.

Condition or evidence	Supplied value
Original interval or clock definition	$1 \leq t \leq 4$
X	$3t - 2$
Y	$t^2 - 5$

Answer. (3, 5)

Explanation and check.

The endpoints change from $(1, -4)$ to $(10, 11)$, giving changes 9 and 15 over an interval of length 3.

AP Precalculus

Parametric Circles

Parametric Circles | APPC-U04-P06

96 problems · Four activity formats

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Topic focus

Across 96 tasks this topic asks for center, radius, start, orientation, exact set-builder list, interval, motion comparison and times, set, direction, parameter-rate comparison and locus, start, period, orientation.

8 PDFs and a README; 139 buyer pages.

AP Precalculus

Parametric Circles

Name: _____ Date: _____ Class: _____

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

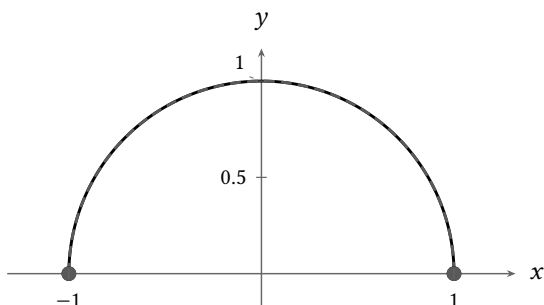
Read the geometric and traversal features from the paired rule.

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

Condition or evidence	Supplied value
Original parameter range or clock definition	t real
Given $x(t)$	$3 + 4 \cos(t)$
Given $y(t)$	$-2 + 4 \sin(t)$

Bank label: _____

Compare the two restricted maps as arc sets and as directed traversals.



Condition or evidence	Supplied value
Original parameter range or clock definition	$0 \leq t \leq \pi$ and $-\pi \leq s \leq 0$
First motion rule	$(\cos t, \sin t)$
Second motion rule	$(\cos(-s), \sin(-s))$

Bank label: _____

Model the ninety-second clockwise revolution from the delayed leftmost start.

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

Condition or evidence	Supplied value
Given center	1 2
Original parameter range or clock definition	time t in seconds
Given direction	clockwise
Period seconds	90
Given radius	3
Start point	-2 2
Start time	30

Bank label: _____

Account for the doubled angle when choosing the lower half-circle parameter window.

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

Condition or evidence	Supplied value
Given arc	lower semicircle
Original parameter range or clock definition	to be selected
Given ending position	1 0
Given endpoint membership	both included
Given direction	counterclockwise
Given coordinate rule	$x = \cos(2t), y = \sin(2t)$
Given starting position	-1 0

Bank label: _____

AP Precalculus

Parametric Circles

Name: _____ Date: _____ Class: _____

Begin at START. Solve the card, use the complete requested response as the outgoing match, and move to the unique card whose incoming header matches it; continue until FINISH.

Incoming: $x = 3 \sin(t)$, $y = 2 - 3 \cos(t)$. Construct a rule that begins at the top and initially moves right. Solve the card, use the complete requested response as the outgoing match, and move to the unique card whose incoming header matches it; continue until FINISH. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Condition or evidence</th> <th style="width: 50%;">Supplied value</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Given center</td> <td style="text-align: center;">-3</td> </tr> <tr> <td style="text-align: center;">2</td> </tr> <tr> <td>Original parameter range or clock definition</td> <td>t real</td> </tr> <tr> <td>Given direction</td> <td>clockwise</td> </tr> <tr> <td>Given radius</td> <td>4</td> </tr> <tr> <td rowspan="2">Given starting position</td> <td style="text-align: center;">-3</td> </tr> <tr> <td style="text-align: center;">6</td> </tr> </tbody> </table> Your response: _____	Condition or evidence	Supplied value	Given center	-3	2	Original parameter range or clock definition	t real	Given direction	clockwise	Given radius	4	Given starting position	-3	6	Incoming: $x = -4 \cos(t)$, $y = \sin(t)$. Can any increasing parameter interval satisfy the endpoint and sweep requirements simultaneously? Solve the card, use the complete requested response as the outgoing match, and move to the unique card whose incoming header matches it; continue until FINISH. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Condition or evidence</th> <th style="width: 50%;">Supplied value</th> </tr> </thead> <tbody> <tr> <td>Original parameter range or clock definition</td> <td>to be selected</td> </tr> <tr> <td rowspan="2">Given ending position</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">0</td> </tr> <tr> <td>Required sweep</td> <td>exactly one-half revolution</td> </tr> <tr> <td>Given coordinate rule</td> <td>$x = \cos(t)$, $y = \sin(t)$</td> </tr> <tr> <td rowspan="2">Given starting position</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">0</td> </tr> </tbody> </table> Your response: _____	Condition or evidence	Supplied value	Original parameter range or clock definition	to be selected	Given ending position	1	0	Required sweep	exactly one-half revolution	Given coordinate rule	$x = \cos(t)$, $y = \sin(t)$	Given starting position	1	0
Condition or evidence	Supplied value																												
Given center	-3																												
	2																												
Original parameter range or clock definition	t real																												
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AP Precalculus

Parametric Circles

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.

The radius, phase, and orientation are correct, but one center coordinate is not. Repair it.

Identify the error or first invalid step, give the corrected result, and state a brief mathematical reason.

Condition or evidence	Supplied value
Original parameter range or clock definition	t real
Student rule to examine	$x = 1 + 3 \cos(t), y = 2 + 3 \sin(t)$
Given target requirements	Given center $1, -2$ Given direction counterclockwise Given radius 3 Given starting position $4, -2$

Parametric Circles

Full Worked Solutions - excerpt

Worked example

Problem. Read the basic circle geometry from the constants and amplitudes.

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

Condition or evidence	Supplied value
Original parameter range or clock definition	t real
Given $x(t)$	$-2 + 6 \cos(t)$
Given $y(t)$	$4 + 6 \sin(t)$

Answer. Center $(-2, 4)$, radius 6.

Explanation and check.

The coordinate midlines are -2 and 4 , and both components have amplitude 6.

Worked example

Problem. Identify the circle's center and radius from the paired rule.

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

Condition or evidence	Supplied value
Original parameter range or clock definition	t real
Given $x(t)$	$5 + 2 \cos(t)$
Given $y(t)$	$1 + 2 \sin(t)$

Answer. Center $(5, 1)$ and radius 2.

Explanation and check.

The additive constants locate the center, and the equal sinusoidal amplitudes give the radius.