

Precalculus
Vectors & Matrix Geometry | 7-Topic Precalculus Bundle

7-topic bundle | 672 problems | Four activity formats

Included topics

The following pages list all 7 included resources in the suggested order, with a link to each product. Each resource retains its complete 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.

56 PDFs and 7 READMEs; 650 buyer PDF pages across the 7 products.

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

Sets & Steps

Math Practice & Worked Solutions

Precalculus

Included topics

7-topic bundle | 672 problems | Four activity formats

01 Vector Components and Direction

[View individual product and its full preview](#)

02 Vector Operations and Magnitude

[View individual product and its full preview](#)

03 Matrix Operations and Multiplication

[View individual product and its full preview](#)

04 Determinants and Area

[View individual product and its full preview](#)

05 Matrices for Linear Transformations

[View individual product and its full preview](#)

06 Composing Matrix Transformations

[View individual product and its full preview](#)

07 Inverse Transformations and Preimages

[View individual product and its full preview](#)

7 included resources | Complete resource previews follow this guide.

Published by Tusils LLC.

AP Precalculus
Vector Components and Direction

Vector Components and Direction | APPC-U04-P10

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 classification with decisive evidence, vector, components, relations with components, equal, opposite, and non-equivalent relations and components and relation.

8 PDFs and a README; 146 buyer pages.

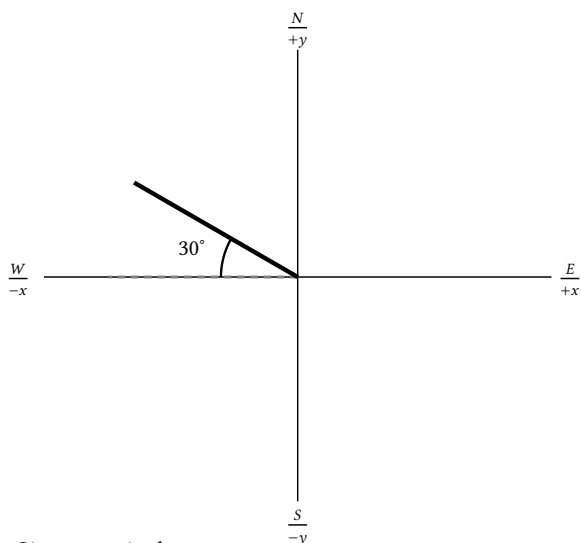
AP Precalculus

Vector Components and Direction

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.

Resolve the west-based heading into east and north components.



Bank label: _____

Find the directed component changes.

Domain: Cartesian plane; Head: (2, 1); Tail: (5, 5)

Bank label: _____

AP Precalculus

Vector Components
and Direction

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.

Do the two directed segments represent the same free vector even though they start at different points? Required response <table><tr><th>Arrow</th><th>Tail (x, y)</th><th>Head (x, y)</th></tr><tr><td>A</td><td>1, 2</td><td>5, 5</td></tr><tr><td>B</td><td>-3, 0</td><td>1, 3</td></tr></table>	Arrow	Tail (x, y)	Head (x, y)	A	1, 2	5, 5	B	-3, 0	1, 3	State the magnitude and standard-position direction of the vector. Components: (0, 7); Domain: Cartesian plane; angles in degrees when stated
Arrow	Tail (x, y)	Head (x, y)								
A	1, 2	5, 5								
B	-3, 0	1, 3								

AP Precalculus

**Vector Components
and Direction**

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

Find the vector directed from the stated tail to the stated head.

Domain: Cartesian plane; angles in degrees when stated; Head: $(7, 1)$; Tail: $(2, 3)$

Your response: _____

AP Precalculus

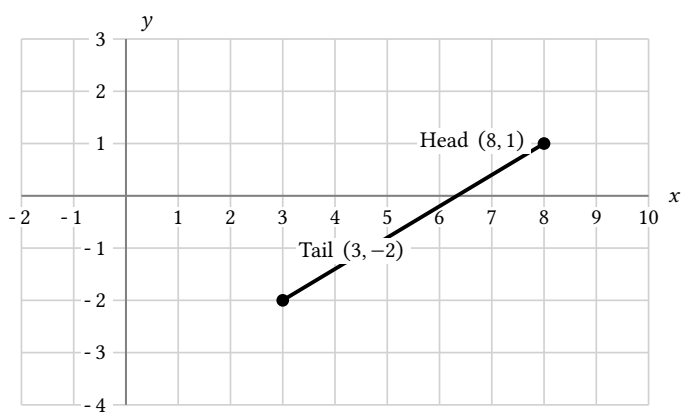
Vector Components and Direction

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.

Explain why the student's ordered pair is not the vector and give the correct components.

Domain: Cartesian plane; angles in degrees when stated; Head: $(8, 1)$; Student claim: The vector is $\langle 8, 1 \rangle$; Tail: $(3, -2)$



Given arrow

Vector Components and Direction

Full Worked Solutions - excerpt

Worked example

Problem. Find the vector directed from the stated tail to the stated head.

Domain: Cartesian plane; angles in degrees when stated; Head: $(7, 1)$; Tail: $(2, 3)$

Answer. $\langle 5, -2 \rangle$

Explanation and check.

Subtracting tail coordinates from head coordinates gives horizontal change 5 and vertical change -2 .

Worked example

Problem. Find the terminal point of the directed segment.

Domain: Cartesian plane; angles in degrees when stated; Tail: $(-2, 5)$; Vector: $(4, -3)$

Answer. The head is $(2, 2)$.

Explanation and check.

The head equals the tail plus the displacement, giving $(-2 + 4, 5 - 3) = (2, 2)$.

AP Precalculus
Vector Operations and Magnitude

Vector Operations and Magnitude | APPC-U04-P11

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
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08	Terms of Use & License	included

Topic focus

Across 96 tasks this topic asks for components, components of $u+v$, resultant and endpoint, resultant and final head, squared norms and longer expression and longer derived vector and exact squared norms.

8 PDFs and a README; 97 buyer pages.

AP Precalculus

Vector Operations and Magnitude

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.

Combine the three displacements u, v, and w. Use the expression $u + v + w$. $u = \langle 1, 4 \rangle$ $v = \langle -3, 2 \rangle$ $w = \langle 5, -1 \rangle$ _____ Bank label: _____	Multiply each component by the scalar. Use the expression $3u$. $u = \langle -2, 3 \rangle$ _____ Bank label: _____
Compute the vector obtained by reversing u and multiplying its length by four. Use the expression $-4u$. $u = \langle -1, 2 \rangle$ _____ Bank label: _____	Construct the unit vector preserving the direction. The given vector is $\langle -7, 24 \rangle$. _____ Bank label: _____
Scale the direction to length 5 without rounding. The required magnitude is 5. Use the same direction as the given vector. The given vector is $\langle 12, -5 \rangle$. _____ Bank label: _____	Construct the requested length without changing the downward direction. The required magnitude is 4. Use the same direction as the given vector. The given vector is $\langle 0, -9 \rangle$. _____ Bank label: _____
Undo the subtraction to recover u. Use the equation $u - \langle 2, 7 \rangle = \langle -5, 1 \rangle$. _____ Bank label: _____	Find the missing second summand. Use the equation $u + v = \text{resultant}$. The resultant is $\langle 7, 2 \rangle$. $u = \langle -4, 9 \rangle$ _____ Bank label: _____

AP Precalculus

**Vector Operations
and Magnitude**

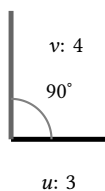
Name: _____ Date: _____ Class: _____

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.

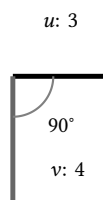
Use the right triangle formed by the two vectors to find the resultant magnitude.

The included angle, in degrees, is 90.

The vector magnitudes are $|u| = 3$ and $|v| = 4$.



One permitted placement



Reflected permitted placement

The two panels show alternative placements of the same data.

No absolute coordinate orientation is specified.

AP Precalculus

Vector Operations
and Magnitude

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 Vector v points in the same direction as u and has magnitude $2\sqrt{13}$. Find v. The magnitude of v is $2\sqrt{13}$. The relation is v has the same direction as u. $u = \langle 2, -3 \rangle$ Your response: _____	Incoming: $v = \langle 4, -6 \rangle$. Isolate and determine v from the given scaled difference. The given linear combination equals $\langle 1, -14 \rangle$. Use the equation $3u - v = \langle 1, -14 \rangle$. $u = \langle 2, -3 \rangle$ Your response: _____
Incoming: $v = \langle 5, 5 \rangle$. Given $u = 5$, $v = 10$, and $u \cdot v = 20$, determine the smaller angle between the vectors. The dot product $u \cdot v$ is 20. The magnitude of u is 5. The magnitude of v is 10. Your response: _____	Incoming: $\cos \theta = \frac{2}{5}$, so $\theta \approx 66.4^\circ$. Scale the direction to length 9. The required magnitude is 9. Use the same direction as the given vector. The given vector is $\langle -8, -15 \rangle$. Your response: _____
Incoming: $\langle -\frac{72}{17}, -\frac{135}{17} \rangle$ Undo the vector subtraction and verify the recovered minuend. Use the equation $u - v = \langle 4, -7 \rangle$. $v = \langle 2, 5 \rangle$ Your response: _____	Incoming: $u = \langle 6, -2 \rangle$; subtracting v returns $\langle 4, -7 \rangle$. Isolate the unknown vector and check the original equation. Use the equation $2u - v = w$. $v = \langle 1, 5 \rangle$ $w = \langle 7, -3 \rangle$ Your response: _____

AP Precalculus

**Vector Operations
and Magnitude**

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.

Determine whether the scalar relationship gives angle 0° or 180° .

$$u = \langle -2, 5 \rangle$$

$$v = \langle -6, 15 \rangle$$

Vector Operations and Magnitude

Full Worked Solutions - excerpt

Worked example

Problem. Solve the two vector equations simultaneously for u and v .

Use these conditions: $u + v = \langle 1, 9 \rangle$, $2u - v = \langle 8, 3 \rangle$.

Answer. $u = \langle 3, 4 \rangle$ and $v = \langle -2, 5 \rangle$.

Explanation and check.

Adding the equations eliminates v and gives $3u = \langle 9, 12 \rangle$; substitution into the sum then determines v .

Worked example

Problem. Construct the unit vector preserving the direction.

The given vector is $\langle -7, 24 \rangle$.

Answer. $\langle -\frac{7}{25}, \frac{24}{25} \rangle$

Explanation and check.

The component pair has norm 25, so divide both entries by 25.

AP Precalculus
Matrix Operations and Multiplication

Matrix Operations and Multiplication | APPC-U04-P14

96 problems · Four activity formats

01	Answer Bank Challenge	24 tasks
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Topic focus

Across 96 tasks this topic asks for constraint comparison and verdict, numeric and label judgments, constraint and uniqueness conclusion, compatibility verdict and repair, valid and invalid labels with reason and intermediate and final sizes.

8 PDFs and a README; 66 buyer pages.

AP Precalculus

Matrix Operations and Multiplication

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.

State the dimensions of A and give a_{23} .

matrix =

4	0	7
-2	5	-1

Bank label: _____

Compute Ax and confirm the result's dimensions. A : see the labelled matrix A ; domain: matrix-vector multiplication; x : $[4, 5]$.

A =

2	-1
0	3

Bank label: _____

Recover x and y from both product entries and explain why neither condition is redundant. B : see the labelled matrix B ; domain: row vector times invertible-looking coefficient matrix; product: $[5, 1]$; row: $[x, y]$.

B =

1	2
1	-1

Bank label: _____

Use a row-column product to find the meal's total calories. calories per serving: $[80, 120, 50]$; domain: meal calorie total; foods: [fruit, grain, milk]; servings: $[2, 1, 3]$.

Bank label: _____

AP Precalculus

Matrix Operations and Multiplication

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.

Compute AB and BA and identify the entry that disproves commutativity. A : see the labelled matrix A ; B : see the labelled matrix B ; domain: diagonal matrix and shear.

$A =$

2	0
0	1

$B =$

1	3
0	1

Determine all possible x and y . Explain why the two output entries do not give two independent constraints. B : see the labelled matrix B ; domain: row vector product with repeated columns; product: $[5, 5]$; row: $[x, y]$.

$B =$

1	1
1	1

Compute AB and state its dimensions. A : see the labelled matrix A ; B : see the labelled matrix B ; domain: row by rectangular matrix.

$A =$

2	-1
---	----

$B =$

3	0	4
5	2	-2

Is uv defined, and what size matrix results? domain: column times row vectors; u size: 4×1 ; v size: 1×2 .

AP Precalculus

Matrix Operations
and Multiplication

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: $(AB)_{14}=9$. Find x so that the indicated row-column product is 6. column: $[3, 1, 4]$; domain: one selected dot product; product entry: 6; row: $[2, x, -1]$. Your response: _____	Incoming: The product is $\begin{pmatrix} 8 & 9 & 4 \\ 6 & 13 & 8 \end{pmatrix}$. Rows are Site A and Site B, columns are wood, metal, and fabric, and the shared sum runs over basic and advanced kits. Multiply the machine-hours matrix by the energy-rate column. Interpret both outputs and explain the unit cancellation. domain: shift energy use; kilowatt hours per hour: $[6, 2, 5]$; machine columns: [press, lathe, dryer]; shift rows: Evening: $[5, 0, 3]$; Morning: $[2, 4, 1]$. Your response: _____			
Incoming: $BA = CA = \begin{pmatrix} 2 & 0 \\ 4 & 0 \end{pmatrix}$, but $B \neq C$. Right cancellation fails because multiplying by A erases the second column, exactly where B and C differ. Find $(AB)_{23}$ by recognizing the selector row. A row 2: $[0, 1, 0]$; B column 3: $[-4, 7, 2]$; domain: standard basis row selection; target: $(AB)_23$. Your response: _____	Incoming: AA^T is 2×2 and $A^T A$ is 3×3, so they cannot be equal as matrices. State the dimensions of c and give c_{31}. matrix = <table border="1" data-bbox="824 1045 1474 1140"> <tbody> <tr><td>-4</td></tr> <tr><td>7</td></tr> <tr><td>2</td></tr> </tbody> </table> Your response: _____	-4	7	2
-4				
7				
2				
Incoming: The product is (0). Multiply the unit-count matrix by the mass column and interpret the two outputs. domain: factory package mass; factory rows: East: $[5, 2]$; West: $[1, 6]$; mass per unit: $[3, 8]$; product columns: [box, crate]. Your response: _____	Incoming: Morning uses 25 kWh and Evening uses 45 kWh. Each dot product sums machine-hours times kWh per machine-hour over the shared machine labels. Find $(AB)_{12}$. A row 1: $[5, 0]$; B column 2: $[-2, 3]$; domain: selected entry with one zero coordinate; target: $(AB)_12$. Your response: _____			

AP Precalculus

Matrix Operations and Multiplication

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.

Compute both orders and use them to assess the scalar-style claim that a zero product forces one matrix factor to be zero.

A =

1	−1
1	−1

B =

1	1
1	1

The inner labels match and the numeric dimensions conform. Does quantity-in-kilograms times dollars-per-item yield a valid total cost? State a minimal unit repair.

Matrix Operations and Multiplication

Full Worked Solutions - excerpt

Worked example

Problem. Compute the row-by-column matrix product. column: $[7, -2, 5]$; domain: zero row times a column; row: $[0, 0, 0]$.

Answer. The product is (0) .

Explanation and check.

All three row-column contributions are zero.

Worked example

Problem. Find $(AB)_{12}$. A row 1: $[5, 0]$; B column 2: $[-2, 3]$; domain: selected entry with one zero coordinate; target: $(AB)_1 2$.

Answer. $(AB)_{12} = -10$.

Explanation and check.

The dot product is $5(-2) + 0 \cdot 3$, so only the first contribution remains.

AP Precalculus
Determinants and Area

Determinants and Area | APPC-U04-P15

96 problems · Four activity formats

01	Answer Bank Challenge	24 tasks
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Topic focus

Across 96 tasks this topic asks for dot product, determinant, area, singular set and dependence explanation, singular set, determinant and conclusion, empty real solution set with reason and all parameter values and dependence.

8 PDFs and a README; 55 buyer pages.

AP Precalculus

Determinants and Area

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.

Use the lower-triangular structure to evaluate the determinant without an unnecessary cross-product calculation. Required response <table border="1" data-bbox="151 537 797 600"> <tbody> <tr> <td>-3</td> <td>0</td> </tr> <tr> <td>4</td> <td>2</td> </tr> </tbody> </table> _____ Bank label: _____	-3	0	4	2	Use the triangular structure to find the determinant of the matrix. Required response <table border="1" data-bbox="826 510 1471 573"> <tbody> <tr> <td>7</td> <td>0</td> </tr> <tr> <td>-2</td> <td>-3</td> </tr> </tbody> </table> _____ Bank label: _____	7	0	-2	-3
-3	0								
4	2								
7	0								
-2	-3								
Evaluate the determinant. Required response <table border="1" data-bbox="151 842 797 905"> <tbody> <tr> <td>7</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> </tr> </tbody> </table> _____ Bank label: _____	7	0	0	1	Read the determinant from the triangular form. Required response <table border="1" data-bbox="826 842 1471 905"> <tbody> <tr> <td>1</td> <td>5</td> </tr> <tr> <td>0</td> <td>3</td> </tr> </tbody> </table> _____ Bank label: _____	1	5	0	3
7	0								
0	1								
1	5								
0	3								
Find the determinant of the coordinate-swap matrix. Required response <table border="1" data-bbox="151 1176 797 1239"> <tbody> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> </tbody> </table> _____ Bank label: _____	0	1	1	0	Find the determinant after the row swap. Apply this change: interchange row 1 and row 2. The original determinant is 13. _____ Bank label: _____				
0	1								
1	0								
Without reconstructing the entries, find the determinant after the columns are interchanged. Apply this change: interchange the two columns. The original determinant is -5. _____ Bank label: _____	Find the determinant after the stated row scaling. Apply this change: multiply row 2 by $\frac{1}{5}$. The original determinant is 20. _____ Bank label: _____								

AP Precalculus

Determinants and Area

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.

Find the signed and ordinary areas of the spanned parallelogram. The first column is $(0, 1)$. The second column is $(-3, 0)$. 	Find the signed and ordinary areas of the column parallelogram. The first column is $(2, 0)$. The second column is $(0, 5)$.
Compute the signed and ordinary areas and classify the column order. The first column is $(-2, 0)$. The second column is $(0, -7)$. 	The second column is a 90°-degree counterclockwise rotation of the first. Use that structure to determine the signed and ordinary areas of their parallelogram. The first column is $(3, -1)$. The second column is $(1, 3)$.
Find the determinant and ordinary area, then state the exact column relation. The first column is $(-1, -2)$. The second column is $(-3, -6)$. 	Find the parallelogram's ordinary area and classify the ordered-column orientation. The first column is $(4, 1)$. The second column is $(1, 3)$. The vertices are $(0, 0)$, $(4, 1)$, $(1, 3)$, $(5, 4)$.

AP Precalculus

Determinants and Area

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: The image area is 15 square units, and orientation is preserved.

Verify that the matrices have the same determinant, then show from their columns that they do not define the same map.

Required response

2	0
0	2

1	3
0	4

Your response: _____

Incoming: It is singular for every real t because the second column is always twice the first, and the determinant $2t - 2t$ is identically zero.

Verify the common determinant and give a column-based reason the maps differ.

Required response

2	0
0	1

1	1
-1	1

Your response: _____

Incoming: The determinant is $k^2 + 6$, which is positive for every real k . Therefore there are no real singular parameter values.

Find the square's original area and its image area.

The determinant is 2. The square has side length 3.

Your response: _____

START

Find every real t for which the matrix is singular and explain what happens to its columns then.

Required response

t	2
3	t

Your response: _____

Incoming: The determinant is $2(\frac{3}{4}) - 1(-1) = \frac{5}{2}$. Therefore the original area is $\frac{35}{\frac{5}{2}} = 14$.

Find the image area and state whether orientation is preserved.

The determinant is $\frac{1}{4}$. The original area is 20.

Your response: _____

Incoming: The original area is 9 and the image area is 18 square units.

Find all real t that make the matrix singular and explain why the off-diagonal 1 does not change the condition.

Required response

t	1
0	t

Your response: _____

AP Precalculus

Determinants and Area

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.

Correct the area statement while preserving the sign's geometric information.

The determinant is -7 . The student claims: The parallelogram area is -7 square units..

Repair the statement by identifying the actual column relationship and its area consequence.

Use the matrix $\begin{pmatrix} 2 & 6 \\ 1 & 3 \end{pmatrix}$. The student claims: The determinant is zero, so both columns must be zero..

Repair the claim by stating what equality of determinants does guarantee and one fact showing the maps differ.

Use matrix $A = \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$. Use matrix $B = \begin{pmatrix} 1 & 3 \\ 0 & 4 \end{pmatrix}$. The student claims: Both determinants are 4, so A and B are the same map..

Assess the student's claim using the displayed columns. Then replace it with a correct geometric statement.

The proposed first and second columns, respectively, are $(2, -3)$, $(-4, 6)$. The student claims: If 2×2 determinant is zero, its two columns must be equal..

Determinants and Area

Full Worked Solutions - excerpt

Worked example

Problem. Give two distinct diagonal matrices with determinant 9 and verify them.

Answer. For example, $\begin{pmatrix} 1 & 0 \\ 0 & 9 \end{pmatrix}$ and $\begin{pmatrix} 3 & 0 \\ 0 & 3 \end{pmatrix}$ both have determinant 9, but their diagonal scalings are different.

Explanation and check.

Choose two different factor pairs whose product is 9.

Worked example

Problem. Correct the area statement while preserving the sign's geometric information.

The determinant is -7 . The student claims: The parallelogram area is -7 square units..

Answer. The ordinary area is 7 square units, and the negative determinant indicates reversed orientation.

Explanation and check.

Take an absolute value for area but not for the orientation classification.

AP Precalculus

Matrices for Linear Transformations

Matrices for Linear Transformations | APPC-U04-P17

96 problems · Four activity formats

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Topic focus

Across 96 tasks this topic asks for consistency, uniqueness, and two example matrices, determination and nonlinear compatible rule, determination and two compatible rules, classification and decisive test, classification and matrix and classification.

8 PDFs and a README; 60 buyer pages.

AP Precalculus

Matrices for Linear Transformations

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.

Construct the matrix and use it to map $(2, -1)$ as a check. $T(e_1) = (0, 2)$ $T(e_2) = (3, 0)$ _____ Bank label: _____	Project the point with the displayed matrix. Use the matrix $A = \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}$. Vectors are column vectors. The given point is $(-3, 5)$. _____ Bank label: _____
Determine the complete image of the unit disk under the diagonal projection, including exact segment endpoints. Use the matrix $A = \begin{pmatrix} \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} \end{pmatrix}$. Vectors are column vectors. Use the disk with center $(0, 0)$ and radius 1. _____ Bank label: _____	Solve the two component systems to recover the matrix from these nonbasis correspondences. Assume T is linear. The input-output observations are $(1, 2) \mapsto (5, 1)$; $(2, -1) \mapsto (1, 8)$. _____ Bank label: _____

AP Precalculus

Matrices for Linear Transformations

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.

Construct the projection matrix by tracking both basis vectors onto the line $y = x$. The map acts by orthogonally project onto the line $y = x$. 	Normalize each scaled-axis correspondence to obtain the two basis images. Assume T is linear. The input-output observations are $(2, 0) \mapsto (6, -2)$; $(0, -3) \mapsto (3, 6)$.
Classify the rule using the origin test and distinguish affine from linear behavior. Use the rule $F(x, y) = (x + 2, y - 1)$. 	Do the axis-only samples establish linearity of an unspecified plane map? Exhibit contrasting compatible rules. The input-output observations are $(0, 0) \mapsto (0, 0)$; $(1, 0) \mapsto (1, 0)$; $(2, 0) \mapsto (2, 0)$.
Construct the matrix and explain geometrically why its image is one-dimensional. $T(e_1) = (2, 1)$ $T(e_2) = (-4, -2)$ 	Map the side generators and determine the image area and orientation change. Use the matrix $A = \begin{pmatrix} 1 & 2 \\ 2 & 1 \end{pmatrix}$. Vectors are column vectors. The two side vectors are $u = (1, 0)$ and $v = (0, 2)$.

AP Precalculus

Matrices for
Linear Transformations

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: Because $(1, 1) + (1, -1) = (2, 0)$, outputs require $(2 + k, 4) = (5, 4)$, so $k = 3$. Then $T(e_1) = (\frac{5}{2}, 2)$, $T(e_2) = (-\frac{1}{2}, 2)$, and the matrix is $[[\frac{5}{2}, -\frac{1}{2}], [2, 2]]$. Construct the exact reflection matrix using the double-angle form. The map acts by reflect across the line through the origin making a 30-degree angle with the x-axis. Your response: _____	Incoming: The image generators are $(2, 0)$ and $(1, 2)$. Their determinant has magnitude 4, so the image area is 4. Use the two directed basis images to assemble the standard matrix. $T(e_1) = (0, -2)$ $T(e_2) = (3, 0)$ Your response: _____
Incoming: Under a linearity assumption they determine matrix $[[2, -1], [1, 3]]$. Without that assumption they do not prove the map is linear, because nonlinear rules can share the same two values. Map both points and verify that their known scalar relation survives the transformation. Use the matrix $A = \begin{pmatrix} 1 & 2 \\ -1 & 3 \end{pmatrix}$. Vectors are column vectors. The given points are $P = (2, 1)$; $Q = (-6, -3)$. The relation is $Q = -3P$. Your response: _____	Incoming: Every member is linear, with matrix $[[a, b], [c, d]]$. Normalize the two scaled basis correspondences and construct the standard matrix. Assume T is linear. The input-output observations are $(2, 0) \mapsto (6, -2)$; $(0, -3) \mapsto (-6, -9)$. Your response: _____
Incoming: The matrix is $[[0, 1], [-1, 0]]$. Complete the image table for all three input rows. Use the matrix $A = \begin{pmatrix} -1 & 2 \\ 3 & 1 \end{pmatrix}$. Vectors are column vectors. The given points are $(0, 1)$, $(2, 0)$, $(-1, -2)$. Your response: _____	Incoming: The first rows give matrix $[[1, 3], [2, 4]]$, which sends $(1, 2)$ to $(7, 10)$, not $(8, 10)$. No linear map fits all rows. Recover $T(e_2)$ from the image of $e_1 + e_2$ and construct the matrix. Assume T is linear. The input-output observations are $(1, 0) \mapsto (-1, 4)$; $(1, 1) \mapsto (2, 2)$. Your response: _____

AP Precalculus

**Matrices for
Linear Transformations**

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 student read the rows as basis images. Correct both images and explain the relevant matrix convention.

Use the matrix $A = \begin{pmatrix} 2 & 5 \\ -1 & 3 \end{pmatrix}$. Vectors are column vectors.

Evaluate these student claims: $T(e_1) = (2, 5)$; $T(e_2) = (-1, 3)$.

A student claims: “A 90° rotation produces a different region because every boundary point moves.” Diagnose the first invalid step or assumption, give the corrected conclusion, and justify the correction. Then complete or verify the underlying task: Describe the disk’s image and verify the claim with one boundary point.

Use the matrix $A = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$. Vectors are column vectors.

Use the disk with center $(0, 0)$ and radius 2.

Evaluate this student claim: A 90° rotation produces a different region because every boundary point moves..

Matrices for Linear Transformations

Full Worked Solutions - excerpt

Worked example

Problem. Write the matrix for a half-turn about the origin.

The map acts by rotate 180 degrees about the origin.

Answer. The matrix is $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$.

Explanation and check.

Both basis vectors reverse direction under a half-turn.

Worked example

Problem. Classify the rule and give a matrix representation if one exists.

Use the rule $F(x, y) = (2x - y, 3y)$.

Answer. The rule is linear with matrix $\begin{bmatrix} 2 & -1 \\ 0 & 3 \end{bmatrix}$.

Explanation and check.

Each output coordinate is a constant linear combination of the inputs with no added constant or nonlinear term.

AP Precalculus
Composing Matrix Transformations

Composing Matrix Transformations | APPC-U04-P18

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 projection and product, second matrix and product, all valid ordered pairs and verification principle, all valid pairs, all sequences and exclusions and all valid sequences and exclusion.

8 PDFs and a README; 156 buyer pages.

AP Precalculus

Composing Matrix Transformations

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.

Compute both orders and decide whether these maps commute.

Use the reflection matrix $\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$. Use the scaling matrix $\begin{pmatrix} 2 & 0 \\ 0 & 3 \end{pmatrix}$.

Bank label: _____

AP Precalculus

Composing Matrix Transformations

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.

Construct the ordered composite and verify it stage by stage. First apply $\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$. Then apply $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$. The original input vector is $(1, 2)$. _____ _____	Classify all allowed two-stage sequences that produce reflection across $y = x$. The allowed transformations are exactly one 90-degree counterclockwise rotation and one coordinate-axis reflection. The target matrix is $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$. _____ _____
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AP Precalculus

Composing Matrix Transformations

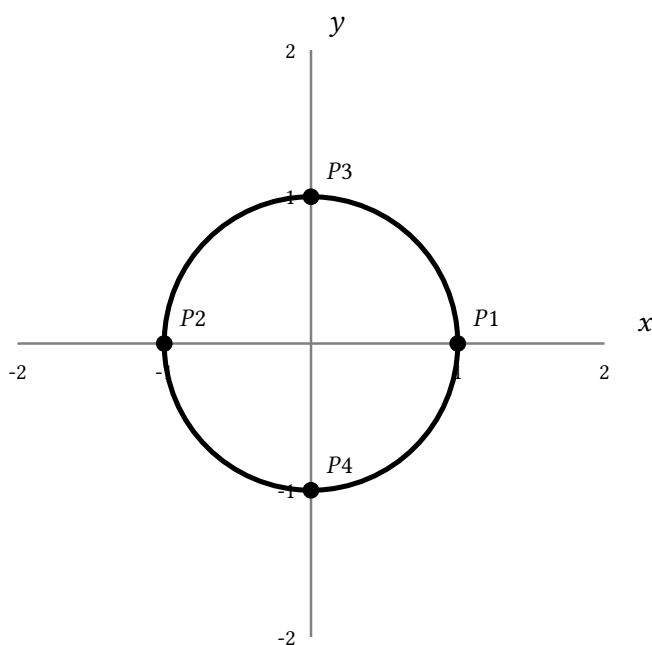
Name: _____ Date: _____ Class: _____

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: The first two stages form a half-turn; the final product is $\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$, reflection across the y -axis.

Track the four key boundary points and state the major-axis direction after each stage.

The boundary points are $(1, 0)$, $(-1, 0)$, $(0, 1)$, $(0, -1)$. First apply $\begin{pmatrix} 2 & 0 \\ 0 & 1 \end{pmatrix}$. Then apply $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$.



Your response: _____

AP Precalculus**Composing Matrix Transformations****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 multiplies the two matrices in the written transformation order and claims the composite is the first matrix times the second. Identify the order error, construct the correct composite, and verify it on the test vector.

First apply $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$. Then apply $\begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$. The original input vector is $(2, 1)$.

Composing Matrix Transformations

Full Worked Solutions - excerpt

Worked example

Problem. Compare both orders and identify their common net action.

Use matrix $A = \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$. Use matrix $B = \begin{pmatrix} -0.5 & 0 \\ 0 & -0.5 \end{pmatrix}$.

Answer. Both products equal $-I$, so either order is a half-turn with no change in length.

Explanation and check.

Scalar matrices commute, and the scale factors multiply to -1 .

Worked example

Problem. Complete the table and explain why the final column returns to the original data.

First apply $\begin{pmatrix} 1 & 2 \\ 0 & 1 \end{pmatrix}$. Use the points $A: (1, 2)$; $B: (-2, 1)$; $C: (0, -3)$. Then apply $\begin{pmatrix} 1 & -2 \\ 0 & 1 \end{pmatrix}$.

Answer. Intermediate: $A = (5, 2)$, $B = (0, 1)$, $C = (-6, -3)$. Final: $A = (1, 2)$, $B = (-2, 1)$, $C = (0, -3)$, the original points.

Explanation and check.

The second shear subtracts the same vertical-coordinate multiple that the first added.

AP Precalculus
Inverse Transformations and Preimages

Inverse Transformations and Preimages | APPC-U04-P19

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 inverse existence and two inverse images, conclusion and example matrices, qualified conclusion, existence and uniqueness qualifications, all preimages and all inputs and geometric set.

8 PDFs and a README; 70 buyer pages.

AP Precalculus

Inverse Transformations
and Preimages

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.

Recover the original rectangle and state its width and height. Required response <table border="1" style="border-collapse: collapse;"> <tr><td style="padding: 2px 10px;">2</td><td style="padding: 2px 10px;">0</td></tr> <tr><td style="padding: 2px 10px;">0</td><td style="padding: 2px 10px;">$\frac{1}{2}$</td></tr> </table> <table border="1" style="border-collapse: collapse;"> <tr><td style="padding: 2px 10px;">-4</td><td style="padding: 2px 10px;">-1</td></tr> <tr><td style="padding: 2px 10px;">4</td><td style="padding: 2px 10px;">-1</td></tr> <tr><td style="padding: 2px 10px;">4</td><td style="padding: 2px 10px;">1</td></tr> <tr><td style="padding: 2px 10px;">-4</td><td style="padding: 2px 10px;">1</td></tr> </table> 	2	0	0	$\frac{1}{2}$	-4	-1	4	-1	4	1	-4	1	Determine whether the target has any preimage. The target point is $(4, 1)$. Required response Forward matrix <table border="1" style="border-collapse: collapse; margin-top: 10px;"> <tr><td style="padding: 2px 10px;">1</td><td style="padding: 2px 10px;">0</td></tr> <tr><td style="padding: 2px 10px;">0</td><td style="padding: 2px 10px;">0</td></tr> </table> 	1	0	0	0
2	0																
0	$\frac{1}{2}$																
-4	-1																
4	-1																
4	1																
-4	1																
1	0																
0	0																
Decide separately whether the map is determined and whether it has an inverse. Use $T(e_1) = (1, 2)$. Use $T(e_2) = (1, 2)$. Assume that T is linear. 	Explain why these four checks are sufficient for mutual inverses. Assume that F and G are linear. The supplied checks are $G(F(e_1)) = e_1$; $G(F(e_2)) = e_2$; $F(G(e_1)) = e_1$; $F(G(e_2)) = e_2$. 																

AP Precalculus

Inverse Transformations and Preimages

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 claims: “A shear matrix cannot be invertible unless it is diagonal.” Diagnose the first invalid step or assumption, give the corrected conclusion, and justify the correction. Then complete or verify the underlying task: Verify the inverse-function claim on all vectors by checking both compositions.

Required response

1	1	1	−1
0	1	0	1

Repair the claim that one recovered input proves a global inverse function.

Use the map $F(x, y) = (x, 0)$.

The student proposes the preimage $(3, 0)$.

The target point is $(3, 0)$.

Inverse Transformations and Preimages

Full Worked Solutions - excerpt

Worked example

Problem. Prove the product-inverse rule by checking recovery in both directions and naming the undoing order.

Answer. Undo A first and B second. Composing this undoing map before or after the original product cancels adjacent inverse pairs and gives the identity in both directions.

Explanation and check.

A composite inverse reverses the original factor order so that each action meets its own undoing action.

Worked example

Problem. Prove that the inverse function of B is the original matrix function A .

Assume that $B = A^{-1}$.

Answer. $AB = BA = I$, so A satisfies both defining equations for B^{-1} . Therefore $(A^{-1})^{-1} = A$.

Explanation and check.

The two-sided inverse equations are symmetric in A and B .