

PENTAGON ABCDE IS ROTATED 90 DEGREE CLOCKWISE ABOUT THE ORIGIN TO FORM PENTAGON A'B'C'D'E'.

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UNDERSTANDING GEOMETRIC TRANSFORMATIONS IS A FUNDAMENTAL ASPECT OF COORDINATE GEOMETRY AND ANALYTICAL GEOMETRY. AMONG THESE TRANSFORMATIONS, ROTATION PLAYS A VITAL ROLE IN MANIPULATING SHAPES WITHIN THE COORDINATE PLANE. IN THIS ARTICLE, WE DELVE INTO THE SPECIFIC TRANSFORMATION WHERE A REGULAR OR IRREGULAR PENTAGON, LABELED ABCDE, UNDERGOES A 90-DEGREE CLOCKWISE ROTATION ABOUT THE ORIGIN TO PRODUCE A NEW PENTAGON, LABELED A'B'C'D'E'. WE WILL EXPLORE THE PROCESS STEP-BY-STEP, ANALYZE THE RESULTING FIGURE, AND DISCUSS THE IMPLICATIONS OF SUCH A TRANSFORMATION WITH RESPECT TO COORDINATES, SHAPE PROPERTIES, AND GEOMETRIC REASONING.

UNDERSTANDING ROTATION IN COORDINATE GEOMETRY

WHAT IS ROTATION?

ROTATION IS A TRANSFORMATION THAT TURNS A FIGURE AROUND A FIXED POINT, KNOWN AS THE CENTER OF ROTATION, BY A SPECIFIED ANGLE AND DIRECTION. THE KEY PARAMETERS INCLUDE:

- CENTER OF ROTATION: THE FIXED POINT AROUND WHICH THE FIGURE IS ROTATED.
- ANGLE OF ROTATION: THE MEASURE OF TURN, IN DEGREES.
- DIRECTION: USUALLY CLOCKWISE OR COUNTERCLOCKWISE.

IN OUR CASE, THE ROTATION OCCURS ABOUT THE ORIGIN (0,0) BY 90 DEGREES CLOCKWISE.

MATHEMATICAL REPRESENTATION OF ROTATION

THE ROTATION OF A POINT (X, Y) ABOUT THE ORIGIN BY AN ANGLE θ (MEASURED IN DEGREES) IN THE CLOCKWISE DIRECTION CAN BE REPRESENTED BY THE TRANSFORMATION:

$$X' = X \cos \theta + Y \sin \theta$$

$$Y' = -X \sin \theta + Y \cos \theta$$

FOR $\theta = 90^\circ$, THE TRIGONOMETRIC FUNCTIONS SIMPLIFY:

- $\cos 90^\circ = 0$
- $\sin 90^\circ = 1$

THUS, THE ROTATION FORMULAS BECOME:

$$X' = Y$$

$$Y' = -X$$

THIS MEANS EACH POINT'S NEW COORDINATES AFTER A 90° CLOCKWISE ROTATION ARE OBTAINED BY SWAPPING THE X AND Y COORDINATES, THEN CHANGING THE SIGN OF THE NEW Y-COORDINATE.

STEP-BY-STEP ROTATION OF PENTAGON ABCDE

INITIAL COORDINATES OF PENTAGON ABCDE

SUPPOSE THE ORIGINAL PENTAGON ABCDE HAS VERTICES WITH COORDINATES:

- $A(x_1, y_1)$
- $B(x_2, y_2)$
- $C(x_3, y_3)$
- $D(x_4, y_4)$
- $E(x_5, y_5)$

FOR ILLUSTRATION PURPOSES, CONSIDER A SET OF SAMPLE COORDINATES:

- $A(2, 3)$
- $B(4, 5)$
- $C(6, 3)$
- $D(5, 1)$
- $E(3, 1)$

THESE POINTS FORM A PENTAGON IN THE COORDINATE PLANE WITH A SPECIFIC SHAPE AND ORIENTATION.

APPLYING ROTATION TO EACH VERTEX

USING THE ROTATION FORMULAS, EACH VERTEX TRANSFORMS AS FOLLOWS:

VERTEX $A(2, 3)$:

$$\begin{aligned} & \left[\begin{aligned} x' &= y = 3 \\ y' &= -x = -2 \end{aligned} \right] \\ & A'(3, -2) \end{aligned}$$

VERTEX $B(4, 5)$:

$$\begin{aligned} & \left[\begin{aligned} x' &= 5 \\ y' &= -4 \end{aligned} \right] \\ & B'(5, -4) \end{aligned}$$

VERTEX $C(6, 3)$:

$$\begin{aligned} & \left[\begin{aligned} x' &= 3 \\ y' &= -6 \end{aligned} \right] \\ & C'(3, -6) \end{aligned}$$

VERTEX $D(5, 1)$:

$$\begin{aligned} & \left[\begin{aligned} x' &= 1 \\ y' &= -5 \end{aligned} \right] \end{aligned}$$

$$Y' = -5$$

$$\backslash$$

$$D'(1, -5)$$

VERTEX E(3, 1):

$$\backslash$$

$$X' = 1$$

$$\backslash$$

$$\backslash$$

$$Y' = -3$$

$$\backslash$$

$$E'(1, -3)$$

VERTICES OF PENTAGON A'B'C'D'E'

AFTER ROTATION, THE VERTICES OF THE NEW PENTAGON ARE:

- A' (3, -2)
- B' (5, -4)
- C' (3, -6)
- D' (1, -5)
- E' (1, -3)

PLOTTING THESE POINTS REVEALS THE ROTATED PENTAGON'S NEW POSITION, SHAPE, AND ORIENTATION.

PROPERTIES OF THE ROTATED PENTAGON

SHAPE PRESERVATION

ROTATION IS AN ISOMETRIC TRANSFORMATION, MEANING IT PRESERVES:

- DISTANCES BETWEEN POINTS
- ANGLES
- OVERALL SHAPE AND SIZE

THEREFORE, PENTAGON ABCDE AND A'B'C'D'E' ARE CONGRUENT; THEY HAVE IDENTICAL SHAPES AND SIZES, JUST ORIENTED DIFFERENTLY WITHIN THE PLANE.

ORIENTATION AND REFLECTION

- THE ORIGINAL PENTAGON ABCDE HAS A SPECIFIC ORIENTATION IN THE PLANE.
- AFTER ROTATION, THE PENTAGON A'B'C'D'E' APPEARS ROTATED 90° CLOCKWISE, WHICH CHANGES ITS ORIENTATION BUT NOT ITS DIMENSIONS.

COORDINATE CHANGES AND GEOMETRIC INTUITION

- THE TRANSFORMATION SWAPS THE X AND Y COORDINATES (WITH A SIGN CHANGE).
- THE PENTAGON'S VERTICES MOVE FROM THEIR ORIGINAL POSITIONS TO NEW LOCATIONS, EFFECTIVELY ROTATING THE ENTIRE FIGURE AROUND THE ORIGIN.

IMPLICATIONS OF ROTATION ABOUT THE ORIGIN

ROTATION ABOUT A FIXED POINT

- ROTATION ABOUT THE ORIGIN MEANS THE ORIGIN REMAINS FIXED.
- ALL VERTICES MOVE ALONG CIRCULAR PATHS CENTERED AT THE ORIGIN.
- THE DISTANCE FROM EACH POINT TO THE ORIGIN REMAINS UNCHANGED.

DISTANCE PRESERVATION

SINCE ROTATION PRESERVES DISTANCES, THE LENGTHS OF SIDES IN $ABCDE$ ARE IDENTICAL TO THOSE IN $A'B'C'D'E'$. SIMILARLY, THE MEASURES OF ANGLES ARE PRESERVED.

EFFECT ON COORDINATES

- FOR EACH VERTEX, THE NEW COORDINATES ARE DIRECTLY DERIVED FROM THEIR ORIGINAL POSITIONS.
- THIS ALLOWS FOR EASY COMPUTATION AND VISUALIZATION.

APPLICATIONS AND SIGNIFICANCE OF SUCH ROTATIONS IN GEOMETRY

REAL-WORLD APPLICATIONS

- COMPUTER GRAPHICS: ROTATING OBJECTS WITHIN A SCENE.
- ENGINEERING: ANALYZING COMPONENT ORIENTATIONS.
- ROBOTICS: MOVEMENT AND ORIENTATION OF ROBOTIC ARMS.

MATHEMATICAL SIGNIFICANCE

- UNDERSTANDING SYMMETRY AND CONGRUENCE.
- SIMPLIFYING COMPLEX GEOMETRIC PROBLEMS.
- ANALYZING TRANSFORMATIONS IN COORDINATE PLANES.

CONCLUSION

ROTATING A PENTAGON $ABCDE$ BY 90 DEGREES CLOCKWISE ABOUT THE ORIGIN RESULTS IN A NEW PENTAGON $A'B'C'D'E'$ WITH VERTICES DERIVED THROUGH STRAIGHTFORWARD COORDINATE TRANSFORMATIONS. THIS PROCESS EXEMPLIFIES THE ELEGANCE OF COORDINATE GEOMETRY, SHOWCASING HOW ALGEBRAIC FORMULAS TRANSLATE INTO GEOMETRIC MOVEMENTS. THE ROTATION PRESERVES THE SHAPE'S SIZE AND ANGLES, CONFIRMING THE FUNDAMENTAL PROPERTIES OF RIGID TRANSFORMATIONS. WHETHER IN EDUCATIONAL CONTEXTS OR PRACTICAL APPLICATIONS, UNDERSTANDING SUCH TRANSFORMATIONS ENHANCES COMPREHENSION OF SPATIAL RELATIONSHIPS AND GEOMETRIC REASONING.

BY MASTERING THE PRINCIPLES OF ROTATION ABOUT THE ORIGIN, STUDENTS AND PROFESSIONALS ALIKE CAN ANALYZE AND MANIPULATE GEOMETRIC FIGURES WITH CONFIDENCE, LEADING TO DEEPER INSIGHTS INTO THE STRUCTURE AND SYMMETRY OF SHAPES IN THE PLANE.

FREQUENTLY ASKED QUESTIONS

WHAT DOES IT MEAN WHEN PENTAGON ABCDE IS ROTATED 90 DEGREES CLOCKWISE ABOUT THE ORIGIN TO FORM PENTAGON A'B'C'D'E'?

IT MEANS THAT EACH POINT OF THE ORIGINAL PENTAGON ABCDE IS ROTATED 90 DEGREES CLOCKWISE AROUND THE COORDINATE ORIGIN (0,0), RESULTING IN A NEW PENTAGON A'B'C'D'E' POSITIONED DIFFERENTLY IN THE PLANE.

HOW DO YOU PERFORM A 90-DEGREE CLOCKWISE ROTATION OF A POINT ABOUT THE ORIGIN?

TO ROTATE A POINT (x, y) 90 DEGREES CLOCKWISE ABOUT THE ORIGIN, YOU TRANSFORM IT TO $(y, -x)$.

WHAT ARE THE COORDINATES OF THE VERTICES OF PENTAGON A'B'C'D'E' AFTER ROTATION?

THE COORDINATES OF EACH VERTEX ARE OBTAINED BY APPLYING THE ROTATION RULE: (x, y) BECOMES $(y, -x)$. FOR EXAMPLE, IF POINT A IS AT (x_1, y_1) , THEN A' WILL BE AT $(y_1, -x_1)$.

IS THE SHAPE OF THE PENTAGON PRESERVED AFTER ROTATION?

YES, ROTATION IS A RIGID TRANSFORMATION, SO THE SHAPE AND SIZE OF THE PENTAGON ARE PRESERVED, ONLY ITS POSITION AND ORIENTATION CHANGE.

DOES ROTATING A PENTAGON 90 DEGREES CLOCKWISE CHANGE ITS AREA?

NO, ROTATION DOES NOT CHANGE THE AREA OF THE PENTAGON; IT ONLY REORIENTS IT IN THE PLANE.

HOW CAN I VERIFY THAT THE ROTATED PENTAGON A'B'C'D'E' IS CORRECTLY POSITIONED?

YOU CAN VERIFY BY CALCULATING THE COORDINATES OF EACH VERTEX AFTER ROTATION AND CHECKING IF THEY SATISFY THE ROTATION RULE, OR BY PLOTTING THE POINTS TO VISUALLY CONFIRM THE SHAPE AND POSITION.

ARE THERE ANY SPECIAL PROPERTIES OF THE PENTAGON AFTER A 90-DEGREE ROTATION ABOUT THE ORIGIN?

YES, THE PENTAGON REMAINS CONGRUENT TO THE ORIGINAL, MAINTAINING ITS SHAPE AND SIZE, BUT ITS ORIENTATION AND POSITION ARE CHANGED.

WHAT APPLICATIONS MIGHT INVOLVE ROTATING POLYGONS LIKE PENTAGONS ABOUT THE ORIGIN?

APPLICATIONS INCLUDE COMPUTER GRAPHICS, GEOMETRIC TRANSFORMATIONS IN DESIGN, ROBOTICS, AND MATHEMATICAL PROBLEM-SOLVING INVOLVING COORDINATE GEOMETRY.

CAN THE ROTATION BE COMBINED WITH OTHER TRANSFORMATIONS TO ACHIEVE A SPECIFIC SHAPE OR POSITION?

YES, ROTATION CAN BE COMBINED WITH TRANSLATIONS, REFLECTIONS, OR SCALING TO MANIPULATE THE SHAPE'S POSITION,

ORIENTATION, AND SIZE FOR VARIOUS GEOMETRIC OR DESIGN PURPOSES.

ADDITIONAL RESOURCES

Pentagon ABCDE is rotated 90 degree clockwise about the origin to form pentagon A'B'C'D'E'. This transformation not only exemplifies how figures can be manipulated within the coordinate plane but also provides insight into the properties and relationships preserved during such movements. Understanding this rotation involves exploring the original pentagon, the mechanics of rotation about the origin, and the resulting figure, along with the implications and applications of such transformations.

UNDERSTANDING THE ORIGINAL PENTAGON ABCDE

DESCRIPTION AND COORDINATES

The pentagon ABCDE is a five-sided polygon defined by five vertices labeled A, B, C, D, and E. To analyze the rotation, it's essential to understand the original coordinates of these vertices.

Suppose the vertices are given as:

- A(x_1, y_1)
- B(x_2, y_2)
- C(x_3, y_3)
- D(x_4, y_4)
- E(x_5, y_5)

For illustration, let's assume specific coordinates:

- A(2, 1)
- B(4, 3)
- C(3, 5)
- D(1, 4)
- E(0, 2)

This set of points forms a convex pentagon situated in the coordinate plane. The shape's size, orientation, and position will influence how it appears after rotation.

FEATURES AND PROPERTIES

- Shape Type: Convex polygon with five vertices.
- Symmetry: No inherent symmetry unless specified.
- Perimeter and Area: Calculable using coordinate geometry formulas.
- Orientation: The initial shape's orientation affects how it appears after rotation.

ROTATION ABOUT THE ORIGIN: MECHANICS AND FORMULA

THE CONCEPT OF ROTATION IN COORDINATE GEOMETRY

ROTATION INVOLVES TURNING A FIGURE AROUND A FIXED POINT—IN THIS CASE, THE ORIGIN (0,0)—BY A SPECIFIED ANGLE, HERE 90 DEGREES CLOCKWISE. THIS TRANSFORMATION PRESERVES THE SHAPE'S SIZE AND ANGLES BUT CHANGES ITS POSITION AND ORIENTATION.

MATHEMATICAL FORMULA FOR ROTATION

TO ROTATE A POINT (X, Y) CLOCKWISE BY 90 DEGREES ABOUT THE ORIGIN, THE NEW COORDINATES (X', Y') ARE OBTAINED VIA:

$$\begin{aligned} X' &= Y \\ Y' &= -X \end{aligned}$$

THIS FORMULA RESULTS FROM THE ROTATION MATRIX FOR 90 DEGREES CLOCKWISE:

$$\begin{bmatrix} X' \\ Y' \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} X \\ Y \end{bmatrix}$$

APPLYING THIS TO EACH VERTEX TRANSFORMS THE ENTIRE PENTAGON.

IMPLICATIONS OF ROTATION

- ORIENTATION CHANGE: THE SHAPE ROTATES TO A NEW POSITION.
- SIZE PRESERVATION: THE FIGURE'S SCALE REMAINS UNCHANGED.
- COORDINATE TRANSFORMATION: EACH VERTEX'S COORDINATES ARE TRANSFORMED INDIVIDUALLY.

CONSTRUCTING PENTAGON A'B'C'D'E'

APPLYING THE ROTATION TO EACH VERTEX

USING THE ASSUMED COORDINATES, LET'S COMPUTE THE NEW VERTICES:

- A(2, 1):

$x' = 1, \text{ } y' = -2$
So, A' IS AT (1, -2).

- B(4, 3):
 $x' = 3, \text{ } y' = -4$
B' AT (3, -4).

- C(3, 5):
 $x' = 5, \text{ } y' = -3$
C' AT (5, -3).

- D(1, 4):
 $x' = 4, \text{ } y' = -1$
D' AT (4, -1).

- E(0, 2):
 $x' = 2, \text{ } y' = 0$
E' AT (2, 0).

PLOTTING THESE POINTS RESULTS IN THE VERTICES OF THE ROTATED PENTAGON A'B'C'D'E'.

FEATURES OF THE ROTATED PENTAGON

- ORIENTATION: THE SHAPE HAS ROTATED 90 DEGREES CLOCKWISE.
- POSITION: THE FIGURE SHIFTS FROM ITS ORIGINAL POSITION, NOW LOCATED IN THE LOWER RIGHT RELATIVE TO THE ORIGINAL SHAPE.
- SIZE: REMAINS UNCHANGED, AS ROTATION PRESERVES DISTANCES AND ANGLES.

VISUAL AND GEOMETRIC ANALYSIS

VISUALIZING THE ROTATION

VISUALIZING THE TRANSFORMATION AIDS IN UNDERSTANDING HOW THE SHAPE'S APPEARANCE AND ORIENTATION CHANGE. THE ORIGINAL PENTAGON ABCDE, ONCE ROTATED, APPEARS FLIPPED AND SHIFTED, NOW ORIENTED SUCH THAT THE ORIGINAL SIDES ALIGN DIFFERENTLY IN THE PLANE.

SHAPE PROPERTIES POST-ROTATION

- CONGRUENCE: THE ROTATED PENTAGON A'B'C'D'E' IS CONGRUENT TO ABCDE.
- ANGLES: ALL INTERIOR ANGLES REMAIN THE SAME.
- SIDE LENGTHS: ALL SIDE LENGTHS ARE PRESERVED.

COMPARISON OF ORIGINAL AND ROTATED PENTAGONS

FEATURE	ORIGINAL (ABCDE)	ROTATED (A'B'C'D'E')
ORIENTATION	ORIGINAL	90° CLOCKWISE
POSITION	ORIGINAL LOCATION	SHIFTED TO NEW POSITION
SIZE	ORIGINAL SIZE	SAME SIZE
SHAPE	ORIGINAL SHAPE	CONGRUENT SHAPE

APPLICATIONS AND SIGNIFICANCE OF ROTATION IN GEOMETRY

EDUCATIONAL IMPORTANCE

- HELPS STUDENTS VISUALIZE TRANSFORMATIONS.
- REINFORCES UNDERSTANDING OF COORDINATE GEOMETRY.
- DEMONSTRATES PROPERTIES OF CONGRUENCE AND SIMILARITY.

PRACTICAL USES

- COMPUTER GRAPHICS AND IMAGE PROCESSING.
- ENGINEERING DESIGN AND CAD MODELING.
- ROBOTICS AND MOTION PLANNING.

PROS AND CONS OF ROTATION TRANSFORMATIONS

- PROS:
- PRESERVES SIZE AND SHAPE.
 - ALLOWS FLEXIBLE POSITIONING OF FIGURES.
 - FUNDAMENTAL TO UNDERSTANDING SYMMETRY AND TRANSFORMATIONS.
- CONS:
- CAN BE COMPLEX TO VISUALIZE FOR IRREGULAR FIGURES.
 - REQUIRES PRECISE CALCULATIONS FOR ACCURATE RESULTS.
 - MIGHT LEAD TO CONFUSION WITHOUT GRAPHICAL AIDS.

EXTENSIONS AND FURTHER EXPLORATION

ROTATION ABOUT OTHER POINTS

- ROTATION CAN BE PERFORMED ABOUT POINTS OTHER THAN THE ORIGIN, INVOLVING TRANSLATION BEFORE AND AFTER ROTATION.
- THE FORMULAS BECOME MORE COMPLEX BUT FOLLOW SIMILAR PRINCIPLES.

MULTIPLE TRANSFORMATIONS

- COMBINING ROTATION WITH TRANSLATION, REFLECTION, OR SCALING CREATES COMPLEX TRANSFORMATIONS.
- UNDERSTANDING THESE COMBINATIONS IS CRUCIAL IN ADVANCED GEOMETRY AND COMPUTER GRAPHICS.

MATHEMATICAL TOOLS

- COORDINATE GEOMETRY FORMULAS.
- ROTATION MATRICES.
- GRAPHICAL PLOTTING TOOLS FOR VISUALIZATION.

CONCLUSION

THE TRANSFORMATION OF PENTAGON $ABCDE$ INTO $A'B'C'D'E'$ VIA A 90-DEGREE CLOCKWISE ROTATION ABOUT THE ORIGIN EXEMPLIFIES FUNDAMENTAL CONCEPTS IN GEOMETRY. IT DEMONSTRATES HOW FIGURES CAN BE MANIPULATED WHILE PRESERVING THEIR CONGRUENCE, PROVIDING A BASIS FOR UNDERSTANDING MORE COMPLEX TRANSFORMATIONS. SUCH OPERATIONS ARE VITAL NOT ONLY IN THEORETICAL MATHEMATICS BUT ALSO IN PRACTICAL APPLICATIONS LIKE COMPUTER GRAPHICS, ENGINEERING, AND DESIGN. BY MASTERING ROTATION PRINCIPLES, LEARNERS GAIN DEEPER INSIGHT INTO THE DYNAMIC NATURE OF GEOMETRIC FIGURES AND THE SYMMETRIES INHERENT IN SPATIAL ARRANGEMENTS.

Pentagon Abcde Is Rotated 90 Degree Clockwise About The Origin To Form Pentagon A B C D E

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