

Saxon Geometry: Warm Up

LESSON
118

Name _____

Finding Areas of Polygons Using Matrices page 756

New Concepts

Matrix Method of Computing Area of a Polygon

Given a convex polygon with n vertices, (x_1, y_1) , (x_2, y_2) , up to (x_n, y_n) , the area of the polygon is equal to the absolute value of one-half of the determinant of the matrix listing the coordinates vertically.

$$A = \frac{1}{2} \det \begin{bmatrix} x_1 & y_1 \\ x_2 & y_2 \\ \vdots & \vdots \\ x_n & y_n \end{bmatrix}$$

So, the area of the polygon can be given by the formula:

$$A = \left| \frac{1}{2} (x_1y_2 + x_2y_3 + x_3y_4 + \dots + x_ny_1 - y_1x_2 - y_2x_3 - y_3x_4 - \dots - y_nx_1) \right|$$

Example Calculating Area Using Matrices

Calculate the area of the pentagon with vertices $(0, 2)$, $(1, 1)$, $(1, -2)$, $(-2, 0)$ and $(-3, 2)$.

Write the matrix with x -coordinates in the first column and corresponding y -coordinates in the second column.

$\begin{bmatrix} x_1 & y_1 \\ x_2 & y_2 \\ x_3 & y_3 \\ x_4 & y_4 \\ x_5 & y_5 \end{bmatrix}$	$= \begin{bmatrix} 0 & 2 \\ 1 & 1 \\ 1 & -2 \\ -2 & 0 \\ -3 & 2 \end{bmatrix}$	Place the vertices in order, either clockwise or counterclockwise. Start with any vertex.
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Use the matrix method area formula.

$$A = \left| \frac{1}{2} (x_1y_2 + x_2y_3 + x_3y_4 + x_4y_5 + x_5y_1 - y_1x_2 - y_2x_3 - y_3x_4 - y_4x_5 - y_5x_1) \right|$$

$$A = \left| \frac{1}{2} [0(1) + 1(-2) + 1(0) + (-2)(2) + (-3)(2) - 1(2) - 1(1) - (-2)(-2) - (-3)(0) - 0(2)] \right|$$

$$= \left| \frac{1}{2} (-19) \right| = \frac{19}{2} \text{ or } 19.5 \text{ square units}$$

Adaptations Lesson 118
Saxon Geometry 743

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