

Angles in Polygons

by – Matt Rhodes

Activity overview

- *This is a self-contained activity that is designed to incorporate the TI-Nspire Navigator system thereby providing for a paperless activity that can be easily managed during and after the class period.*
- *Students will investigate the relationships of the interior and exterior angles in a polygon. They will make observations through inductive reasoning and the n^{th} term.*

Concepts

Polygons, regular polygons, interior and exterior angles, diagonals, convex /concave, inductive reasoning and the n^{th} term, triangle sum theorem.

Teacher preparation

Students should know navigation on the TI-Nspire. They will need to be able to move from page to page as well as within frames of a page layout. Also, they need a basic understanding of the Calculate tool (expressions are provided for them), the Segment tool and the Regular Polygon tool.

Classroom management tips

Students can be placed in groups of 3-4 or this activity can be presented as a teacher led discussion and discovery.

TI-Nspire Applications

The following applications are used (either TI-Nspire or TI-Nspire CAS will work):

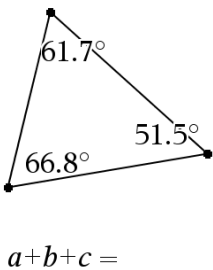
- *Graphs and Geometry*
- *Lists and Spreadsheets*
- *Open Response Questions*
- *Calculator*

Step-by-step directions

Problem 1

Have the students open the file and read the instructions on page 1.2. Then advance to 1.3. To choose the *Calculate* tool, press $\text{[menu]} \text{[1]} \text{[8]}$. Once the tool is active, select the expression under the polygon. The handheld will then prompt the user to “Select a.” Select one of the angle measures. Then, select the other two angles. The sum will then float with the cursor. Move to a convenient location on the screen and drop off your number by pressing [enter] .

Note – Answers are provided in the *Suggested Response* field each time a question is asked.

Triangle	What is the sum of the measures of the interior angles of a triangle?
 <p>$a+b+c =$</p>	<p>Student types answer here</p> <p>Suggested Respo...</p>

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Subject: Mathematics

Time required: Approximately 90 minutes

Advance through pages 1.4, 1.5 and 1.6 following the same instruction as before.

Record the discovered sums from pages 1.3-1.6 in the appropriate fields on page 1.7. Make a conjecture for a heptagon and octagon (900° and 1080° respectively).

Using the table, record your values from the polygon pages. Can you make a conjecture for 7 or 8 sides?


A	B	C	D
◆			
1	3 triangle		
2	4 quadrila...		
3	5 pentagon		

CI

Using the pattern that was established on page 1.7, find the n^{th} term. Be sure to emphasize that in this formula, n is the number of sides (column 1 from our table).

The pattern is easy enough for polygons with only a few sides. However, we will have a need to find the sum of the measures in polygons with larger numbers of sides. Find the n^{th} term for the pattern you have found. Let n equal the number of sides.

Student types answer here

Go back to each polygon and draw all diagonals from one vertex. To choose the segment tool press . Then select the endpoints of each diagonal to draw the line segment. Record the total number of triangles from each polygon in the table on 1.9.

Go back to the polygons. On each page, choose a vertex and use the segment tool to construct all diagonals from that point. Record how many new triangles are created

A	B	C	D
◆			
1	triangle		
2	quadrila...		

A1 triangle

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Since each triangle from our chart in 1.9 represents 180° in each polygon, the number of triangles multiplied by 180 equals the totals for the interior angles that we found on page 1.7.

Based on your knowledge of the sum of the angle measures inside a triangle, how can the pattern in the table support your conjecture from page 1.8?

Student types answer here

Suggested Response:

The pattern suggests that the sum of the measures of the interior angles of a

Problem 2

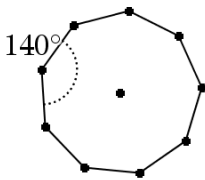
Press $\left[\text{menu} \right] \left[8 \right] \left[5 \right]$ to activate the *Regular Polygon* tool.

Press $\left[\text{center} \right]$ to begin the polygon and then move away from your initial point. Press $\left[\text{center} \right]$ again and you will begin with a 16-gon, by default. Move clockwise around your polygon to choose a smaller number of sides.

Press $\left[\text{menu} \right] \left[7 \right] \left[4 \right]$ to activate the *Angle Measure* tool. Select three points to define the angle you wish to measure, keeping the vertex in the middle.

This measurement can be found quickly by taking the sum of the interior angles, $(n - 2)180$ and dividing it by the number of sides, n .

Regular Polygon



we calculate this number? Insert a calculator page if necessary.

Student types answer here

Suggested Respo...

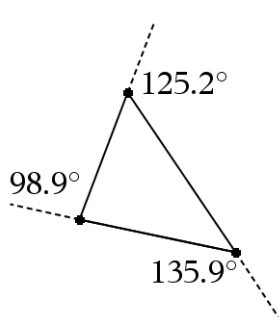
Divide $(n-2)180$

Problem 3

As in Problem 1, you are given polygons with premeasured angles. Of course, we are looking only at exterior angles this time. Sum the measures as we did previously.

Here, the observation is obvious. The sum of the exterior angles of any polygon is 360° .

Triangle



$a+b+c = 360$

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<p>When the polygon becomes concave, the underlying triangles are compromised and the entire proof falls apart.</p> <p>Ideas:</p> <ul style="list-style-type: none">• This is an excellent time for class discussions. Be sure to hear what the students suggest. Great teaching moments arise.• Point out different ways to make the polygon concave. Of course, pulling one point “inside” forces concavity, however you can also pull a point “out” too far and arrive at the same situation.	<p>Now try dragging a vertex of the hexagon on page 3.5 so that it becomes concave. What do you notice? Describe why you think this happens.</p> <p>Student types answer here</p> <p>Suggested Response:</p> <p>The sum does not stay at 360°.</p>
<p>Problem 4</p> <p>Example problems and answers are provided.</p>	

Assessment and evaluation

Use the tools of the Navigator software for ongoing formative assessment during the activity.

Activity can be collected and graded using the Portfolio tool.

Student TI-Nspire Document

Angles in Polygons.tns