Geometer’s Sketchpad Worksheet

Investigation: Finding number of diagonals of a polygon

In this investigation we will discover that there is a positive correlation between the number of sides of a polygon and the number of diagonals in the polygon. Follow the instructions below to construct 4 different polygons and fill in the chart at the end of the Investigation Worksheet. Answer the questions that are on the worksheet below the chart and hand in only that paper.

1. Locate GSP on your programs list on your computer. Open it and maximize your window, giving you a blank new sketch. The window maximize icon is shown below if you are working in Windows.
2. Before you start the investigation, get familiar with the tools that you will use most. These icons are located on the left hand side of your screen. The chart below gives you a brief overview of the icons on the side of your screen and the functions they serve.

- **Selection Arrow Tool**: Allows you to highlight items or groups of items in the sketchpad area. Before going to highlight points, lines and shapes in the sketchpad work area, click on this button first to get the arrow used to highlight items in the working area.

- **Point Tool**: Allows you to draw points in space, on lines and other geometric figures.

- **Straightedge Tool**: Allows you to draw segments, lines and rays from selected point. We will be using segments in this investigation.

- **Text Tool**: Allows you to insert text around your drawings in the sketchpad work area. We will use this tool to label our points on our polygons.

3. Start the investigation by drawing 4 points in space (using the point tool) that are far enough apart to draw segments in between them. See the drawings below to get some idea for placing these points. Place these points in order, either clockwise from your starting point or counter-clockwise from your original point. The drawings below place the points in a clockwise order.
Place this point first, highlighted in blue last.

this one second,  third, and the one that is

4. Using the selection arrow tool, highlight all 4 points by selecting a place “outside” of the 4 points that you have drawn and drag the dotted line box around all 4 points that you have drawn. See the picture below that highlights the 4 points in our example.

5. Using the drop down menu under Construct, then select the Segment option to draw in segments that will outline our polygon. In this case, our polygon is a quadrilateral. Leave all of the points and segments highlighted for the next step. See the picture below for where to find how to connect our points.
This connects all of the points that are located next to each other - the adjacent vertices of the quadrilateral.

6. Use the Display drop down menu to make the “outline” of the shape to have thin lines that are black. You can change the segment width and color by first highlighting the desired segments (and if you followed directions from the last step, they are already highlighted) and then choose the appropriate line width and color from the menus. See the pictures below to find these in the menus.
7. Using the text tool, label each of the points on your graph. Make sure that the point that you started with is labeled point A and then use B for the next point that you plotted and so on. The text tool will assign a letter once you click on a point and then you can slightly drag that letter to where you would like it. See the picture below to give you an idea where to start.

8. For every NON-ADJACENT vertex to a point, draw a diagonal. Use the selection arrow tool to highlight the non-adjacent points and then use the Construct command from the drop down menu as you did in step 5 choosing Segment to connect the 2 points. Use a dashed line for each diagonal that you draw - this was covered in step 6. Use a different color for every new vertex that you move on to. Once you have all of the diagonals drawn to EVERY non-adjacent vertex, you have enough information to complete the chart on the last page. See the picture below to get an idea of what to do with the 4 points.
9. Repeat this process with the appropriate number of points until the chart on the last page is complete. Spacing between the points is crucial so each time you start a new one, open a new sketch using the picture below under the file drop down menu. Before you start a new sketch, it may be a smart idea to save your work so that you can go back to it if you need information later. This option is also in the menu pictured below.

Start this process by placing 5 points. Remember to space them out so you have room to draw the diagonals in later.

Highlight all of the points as we did in step 4.
Connect all of the points using the construct command from the drop down menu as we did in step 5.

Continue through step 8 with these 5 points.
10. Fill out the information on the chart on the last page. The number for the 4 points is already filled out based on the information in the picture in step 8. Complete this chart for all 3 addition drawings that you have constructed. Answer all additional questions on the last page of this packet.

11. Print out all of your drawings or send them as an attachment in an email. If you have wrong answers on the chart you will be graded on how you constructed your drawings. Turn in the last page of this packet when you are finished constructing the 3 additional figures.
1. Use your drawings to fill in the following table:

<table>
<thead>
<tr>
<th>Number of sides or points</th>
<th>Number of diagonals emanating from a single vertex</th>
<th>Total number of diagonals for the figure</th>
<th>Additional diagonals to the previous figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>14</td>
<td>5</td>
</tr>
</tbody>
</table>

2. What kind of pattern do you notice about the number of diagonals from a single vertex from one polygon to another?

They go up by one for each of the points or sides that we add to the figure.

3. What kind of pattern do you notice about the total number of diagonals from one polygon to another?

We are adding 1 more to each of the totals, add 3, then 4, then 5…

4. If you were to draw an octagon, how many diagonals would you expect to have emanating from a single vertex?

5

5. How many would you expect as the total number of diagonals for an octagon?

20
6. Using the patterns that you developed above, extend the chart down to an 11-gon. What would be the total number of diagonals for this figure?

<table>
<thead>
<tr>
<th>Number of sides or points</th>
<th>Number of diagonals emanating from a single vertex</th>
<th>Total number of diagonals for the figure</th>
<th>Additional diagonals to the previous figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>5</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>27</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>7</td>
<td>35</td>
<td>8</td>
</tr>
<tr>
<td>11</td>
<td>8</td>
<td>44</td>
<td>9</td>
</tr>
</tbody>
</table>

7. Develop a formula to figure out the total number of diagonals of an n-gon. Give the formula in terms of D for total diagonals and n for number of sides.

The total number of diagonals would be $D = \frac{n(n-3)}{2}$