

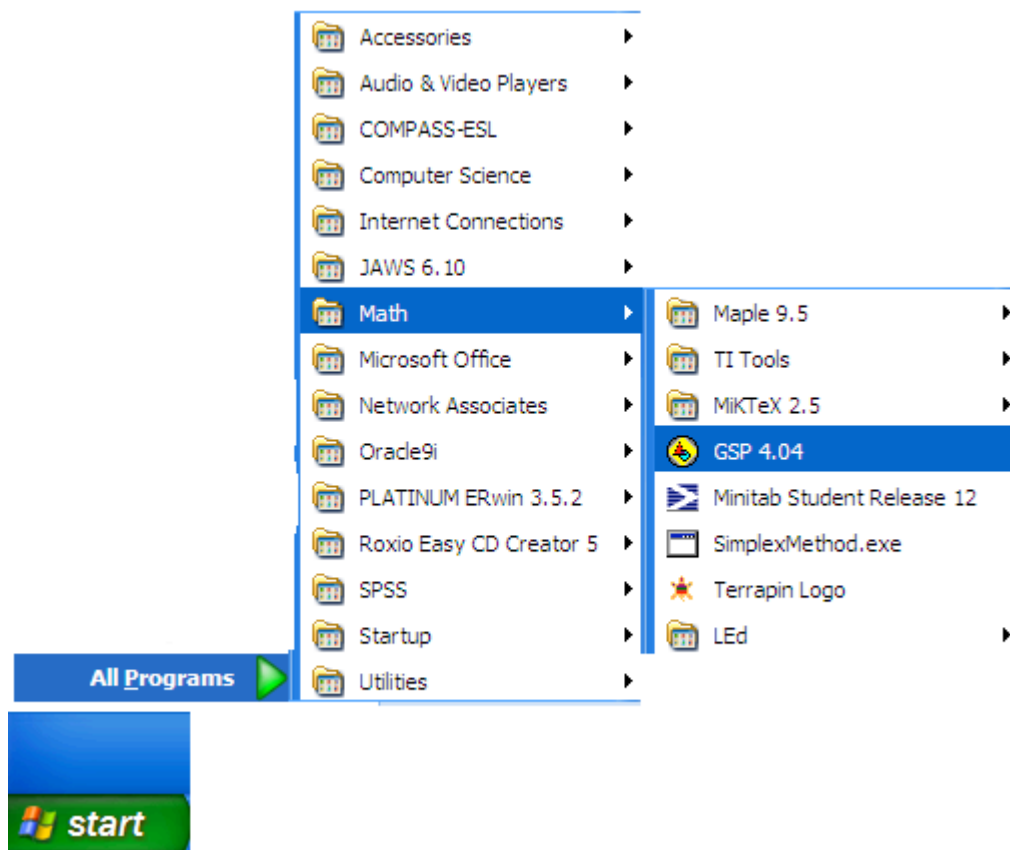
## **Investigation: Area of a Parallelogram**



In this investigation, you will discover properties of the area of a parallelogram. You will make a table that shows the relationships of the segments, angles, and area of a changing parallelogram.



### **Method for Sketch and Reflection Questions:**

**Step 1:** *Opening Geometer Sketch Pad.* a) Click on *Start – All Programs – Math – GSP 4.04.*

*Note: This notation will be used throughout the lesson to move from one selection to another.*

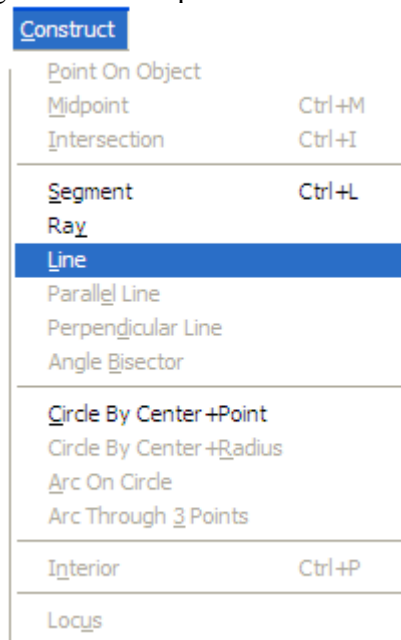


**Step2:** *Constructing a line.* a) Begin by constructing a point on the screen. The point can be anywhere that you want to place it. Select the point tool  from the toolbar on the far left of the Geometer Sketchpad screen. Move your arrow cursor over into the blank area, and left click on time on the field. Your first point should appear: 

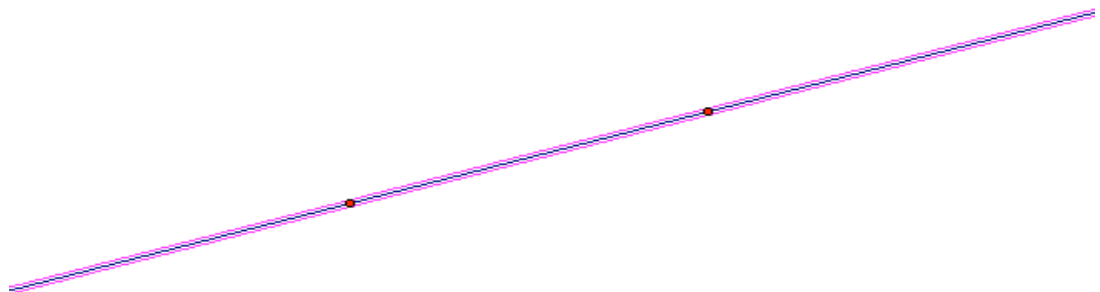
b) Next, create another point in the field (anywhere) and then hit the selection arrow tool on the Toolbar . Your field should now look like this: 

*Note: You will be asked to select the selection arrow tool many times throughout this lesson to prevent from inadvertently selecting items that should not be selected.*


c) Third, select (highlight) both points in the field by clicking on them. They should both look like the bigger of the two points above. Then, select Construct – Line from the menu bar.

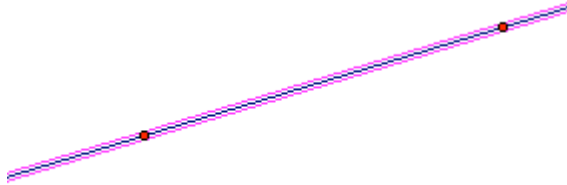


You should now have a line in your field.

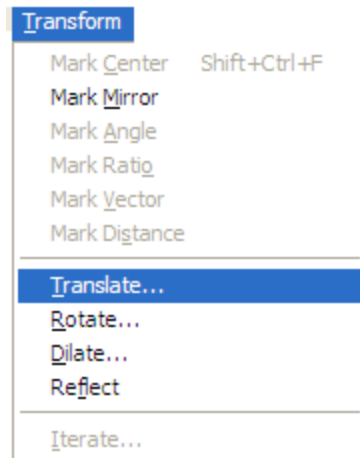


**Step 3: Translating the line (Making a parallel line).** a) For this project, we are going to need to create a parallel line that lies a fixed distance away from our original line. In order to do this, we need to *Translate* our original line. So, begin by selecting the

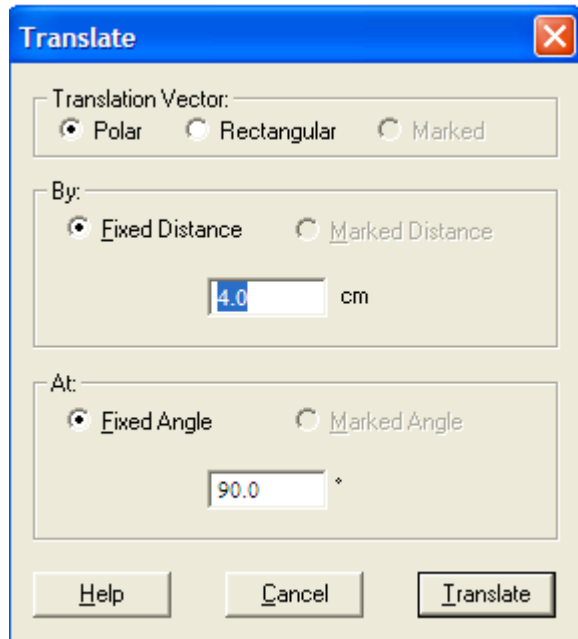
selection arrow tool , and then select the line that we just created at the end of step 2. The line will light up when selected.



b) Select *Transform – Translate* from the menu bar:

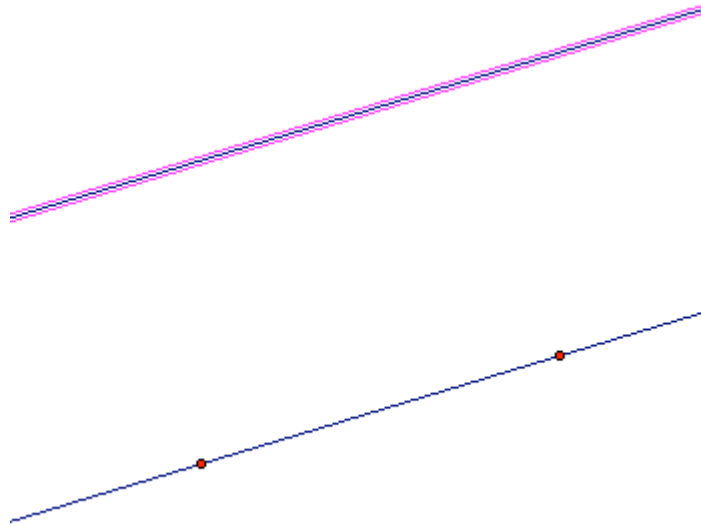



A box should appear that looks like this:




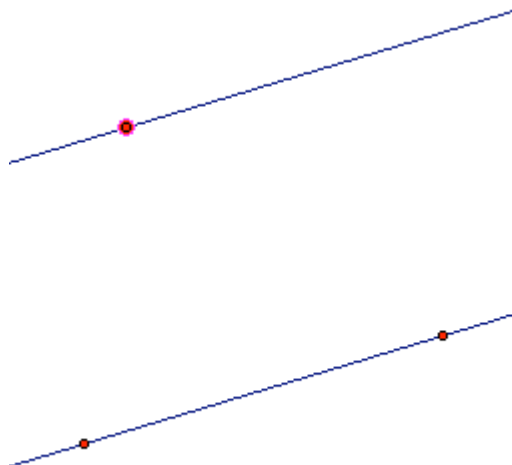
Select a fixed distance of 4.0 cm, and select the Translate button at the bottom of the box


You should now have a line that is parallel to your original line, 4cm away from your original line.




To deselect everything in your field, select the selection arrow tool , and then click on a blank area in your field. This should un-highlight everything that you have drawn.

c) Create one new points (anywhere) on your new line. To do this, choose the point tool , and then scroll over the line with your mouse arrow until the line lights up (becomes highlighted). Then click on the line, your new point should appear.



**Step 4: Naming the points.** a) Select the selection arrow tool , and deselect everything in your field.

Then, select the Text Tool  from the toolbar. The cursor should turn into a little white glove. A black glove should appear when you scroll over each of your points. Once the glove is black, left click on your mouse. Name your points *A*, *B*, and *C* like this:


*Note: Your points will be named in the order that they are selected, so select the bottom left, then bottom right, then the top.*



Next, you can drag the “*A*” from point *A* by left clicking, holding the mouse button, and dragging the “*A*” wherever you would like. Please move the points to look like this:

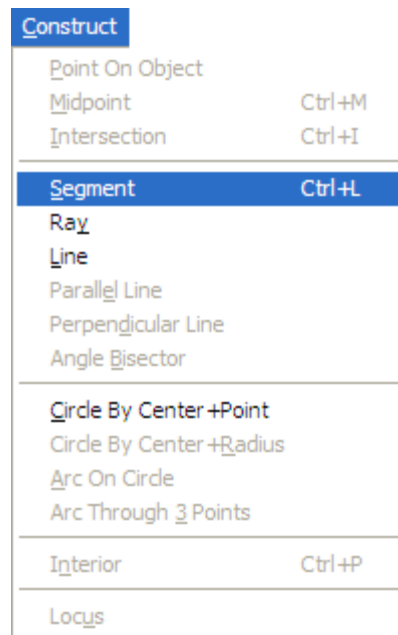


The names of these points will now be used to continue the construction of your parallelogram.

**Step 5: Constructing Segments.** a) Select the selection arrow tool , and deselect everything in your field. Next, select (highlight) the two points (*A* and *B*) on your first (original) line.




b) Next, select the Construct – Segment option from the menu bar.

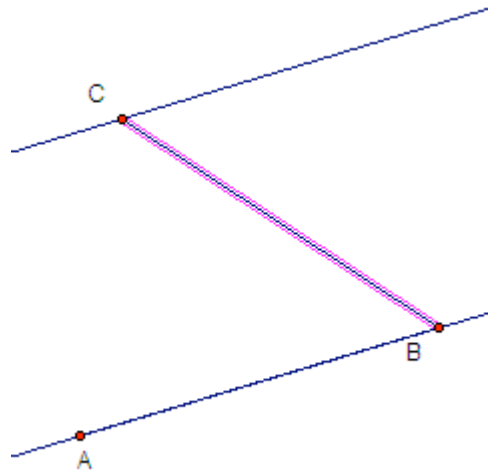



A segment on your line should appear between the two points.

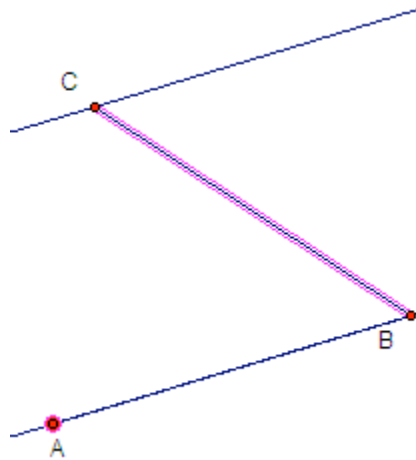


Click into the field (using the , selection arrow tool) to deactivate what was selected.

c) Next, repeat the step above to construct a segment between points  $B$  and  $C$ .



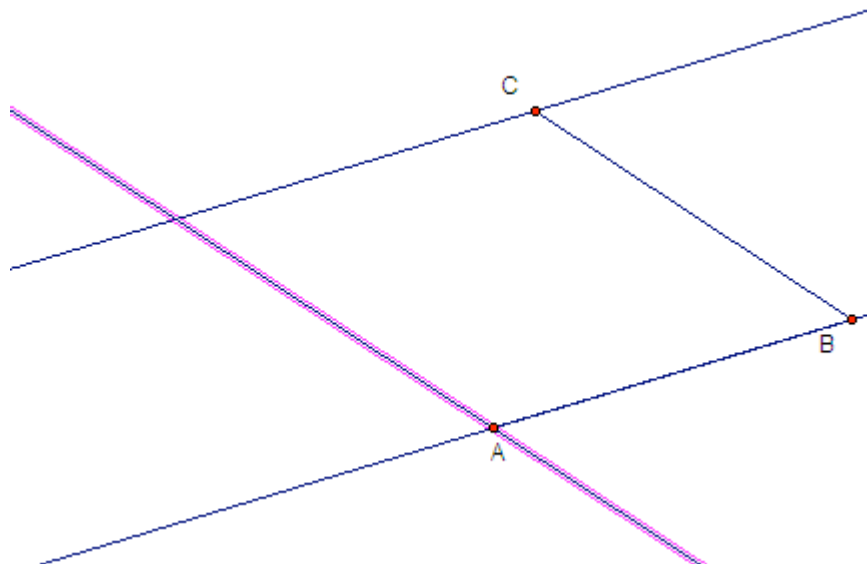
d) This is the most important step of the process. We must now construct a line that is parallel to  $\overline{BC}$  through point  $A$ . So, deselect everything that is highlighted by using the selection arrow tool . Next, highlight  $\overline{BC}$  and point  $A$ .





Then, select *Construct – Parallel Line* from the menu bar.

Construct	
Point On Object	
Midpoint	Ctrl+M
Intersection	Ctrl+I
Segment	Ctrl+L
Ray	
Line	
<b>Parallel Line</b>	
Perpendicular Line	
Angle Bisector	
Circle By Center +Point	
Circle By Center +Radius	
Arc On Circle	
Arc Through 3 Points	
Interior	Ctrl+P
Locus	

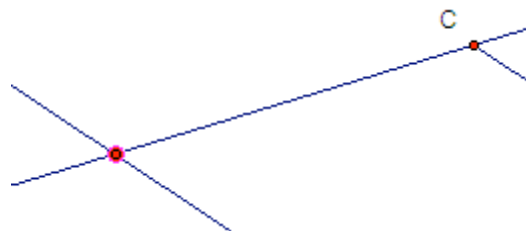
You should have created a parallel line to  $\overline{BC}$  at  $A$ .




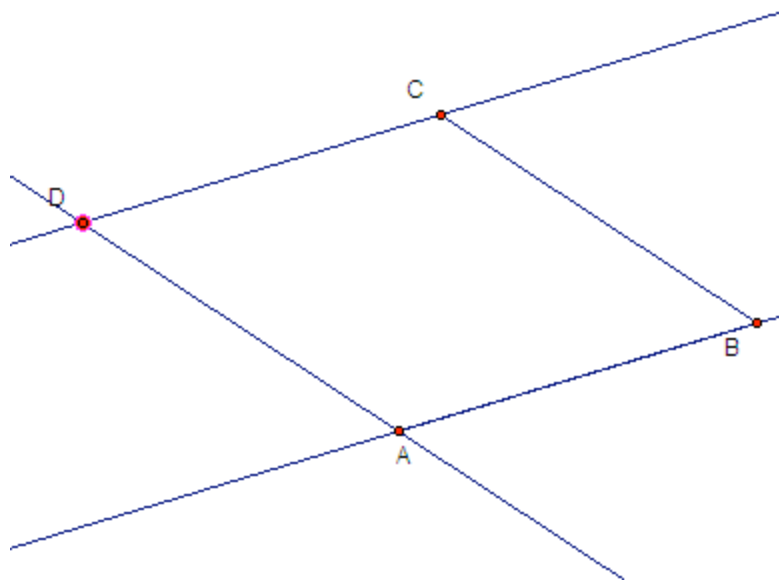
Deselect everything with the selection arrow tool .


e) Select the point tool  from the tool bar, and create a point at the intersection of your new line and the line that contains  $C$ .

*Note: When both lines become highlighted, you will know that this point lies on both lines. Left click to create your point.*




f) Name your new point  $D$  by using the text tool  from your toolbar. Your shape should now look like this:

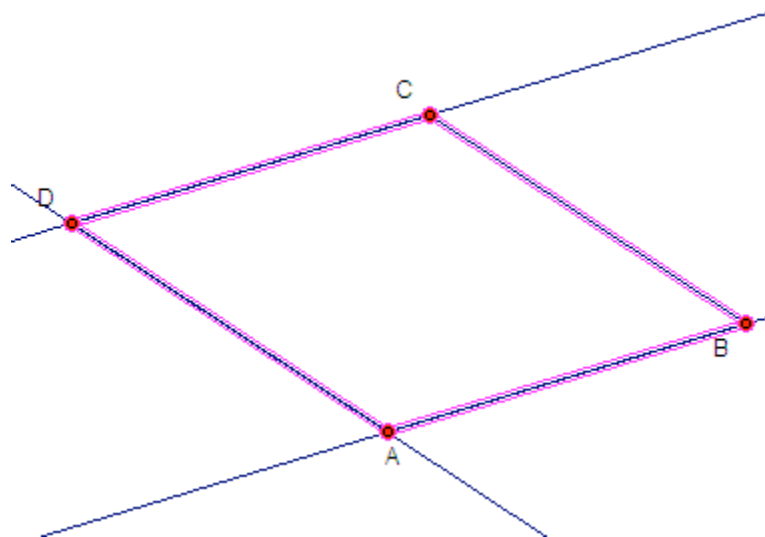


g) Create segments  $\overline{AD}$  and  $\overline{DC}$  by following the same procedure above, and then deselect everything in your field with the selection arrow tool .

**Step 6: Copying what we need.** a) Since we do not need any of the extra lines to complete our project, we need to copy what we need, and paste it into a new sheet.

First, using your selection arrow tool , select (highlight) segments  $\overline{AB}$ ,  $\overline{BC}$ ,  $\overline{CD}$ , and  $\overline{AD}$ , and all four points.

*Note: It is very important that All of the segments and all of the points are highlighted.*



b) Next, select Edit – Copy from the menu bar.

Edit		
U <u>ndo Construct Segment</u>		Ctrl+Z
<u>R</u> edo		Ctrl+R
<hr/>		
Cu <u>t</u>		Ctrl+X
<u>C</u> opy		Ctrl+C
<u>P</u> aste Picture		Ctrl+V
C <u>l</u> ear Segments		Del
<hr/>		
Action <u>B</u> uttons		▶
<hr/>		
Select <u>A</u> ll		Ctrl+A
Select <u>P</u> arents		Ctrl+U
Select <u>C</u> hildren		Ctrl+D
<hr/>		
<u>S</u> plit/Merge		
<u>E</u> dit Definition...		Ctrl+E
<hr/>		
Properties...		Alt+?
<hr/>		
Prefer <u>e</u> nces...		

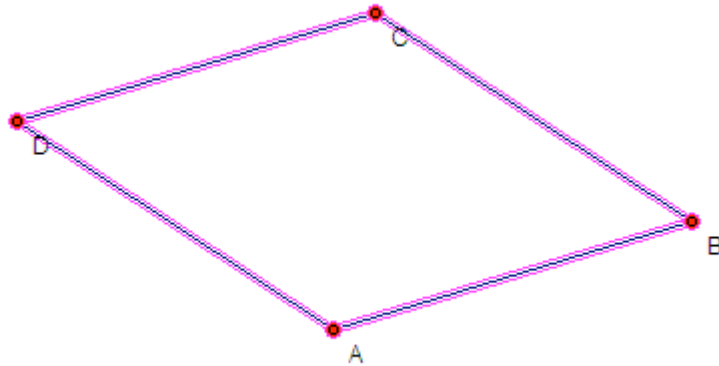
c) Select File – New Sketch from the menu bar.

File		
<u>N</u> ew Sketch		Ctrl+N
<u>O</u> pen...		Ctrl+O
<hr/>		
<u>S</u> ave		Ctrl+S
Save <u>A</u> s...		
<u>C</u> lose...		Ctrl+W
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<u>D</u> ocument Options...		
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Page Setup...		
Print <u>P</u> review...		
Print...		
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<u>Q</u> uit		Ctrl+Q

d) Select Edit – Paste from the menu bar.

Edit		
U <u>ndo Paste Objects</u>		Ctrl+Z
<u>R</u> edo		Ctrl+R
<hr/>		
Cu <u>t</u>		Ctrl+X
<u>C</u> opy		Ctrl+C
<u>P</u> aste		Ctrl+V
C <u>l</u> ear Objects		Del
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Action <u>B</u> uttons		▶
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Select <u>A</u> ll		Ctrl+A
Select <u>P</u> arents		Ctrl+U
Select <u>C</u> hildren		Ctrl+D
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<u>S</u> plit/Merge		
<u>E</u> dit Definition...		Ctrl+E
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Prefer <u>e</u> nces...		

Your drawing should appear in the new sketching area:



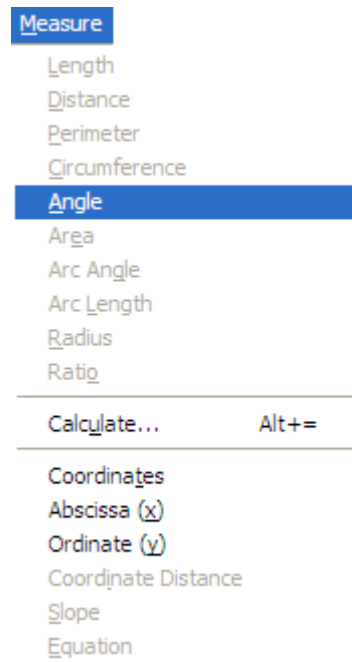
Note: there should be no additional lines than our segments connecting the points of our parallelogram.

**Step 7: Making measurements.** a) Now it is time to make some observations about our parallelogram. First, let's measure the interior angles of our parallelogram.

Using our selection arrow tool , deselect everything in the field.

Then, select (highlight) points *A* then *B* then *C* (they must be in that order, order is very important when measuring angles).

Now, select Measure – Angle from the menu bar.



Your angle measure should now appear in the upper left hand corner of your page.

**Reflection Questions:**

Repeat this process for all of the angles of your parallelogram. Make sure that you clear the field with your selection arrow tool  after measuring each angle.

What are the measures of each of your angles?

Measure  $\angle ABC =$  \_\_\_\_\_

Measure  $\angle BCD =$  \_\_\_\_\_

Measure  $\angle CDA =$  \_\_\_\_\_

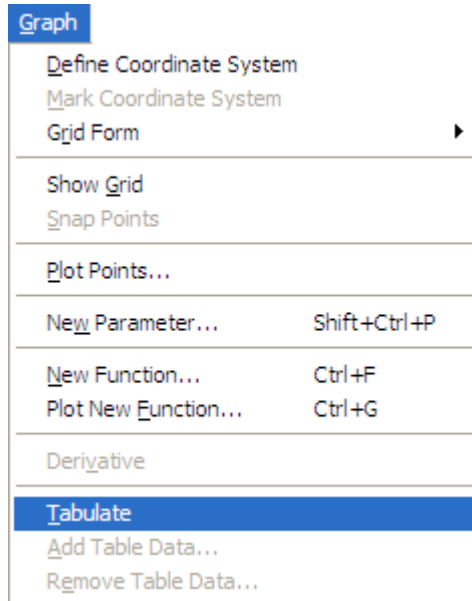
Measure  $\angle DAB =$  \_\_\_\_\_

What do you notice about the relationships of these angles?

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**Step 8:** *Making a table of measurements:* a) Select (highlight) each of your angle measurements. Then select *Graph – Tabulate* from the menu bar.




A table should appear in the upper left hand corner of your page.

Note: Your results may be different than the table below, this is completely normal.

$m\angle ABC = 50.14^\circ$   
 $m\angle BCD = 129.86^\circ$   
 $m\angle CDA = 50.14^\circ$   
 $m\angle DAB = 129.86^\circ$

$m\angle ABC$	$m\angle BCD$	$m\angle CDA$	$m\angle DAB$
$50.14^\circ$	$129.86^\circ$	$50.14^\circ$	$129.86^\circ$

**Step 9:** *Changing our parallelogram.* a) Using our selection arrow tool , deselect everything in your field. Then, highlight point  $C$ . Using your mouse button, click on point  $C$ , hold the mouse button down, and drag point  $C$  to a different location in the field.

**Reflection Questions:**

What happens to the shape of your parallelogram?

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What happens to the angles of the parallelogram?


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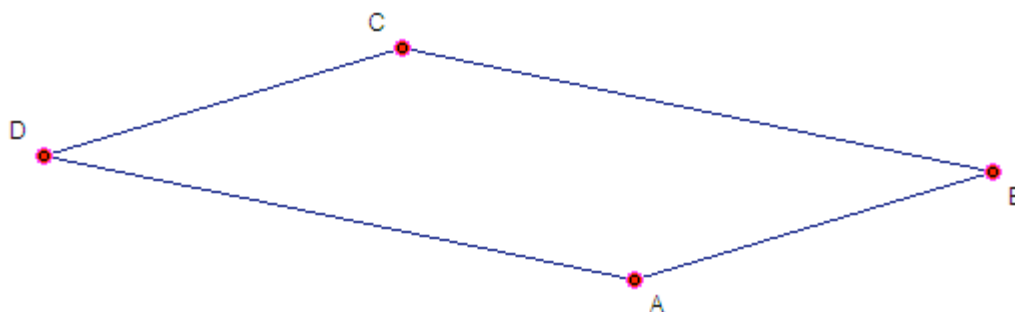
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What happens to the relationship of the angles in my parallelogram?

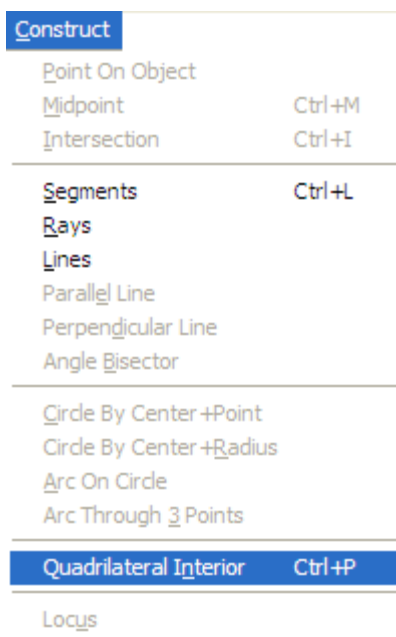
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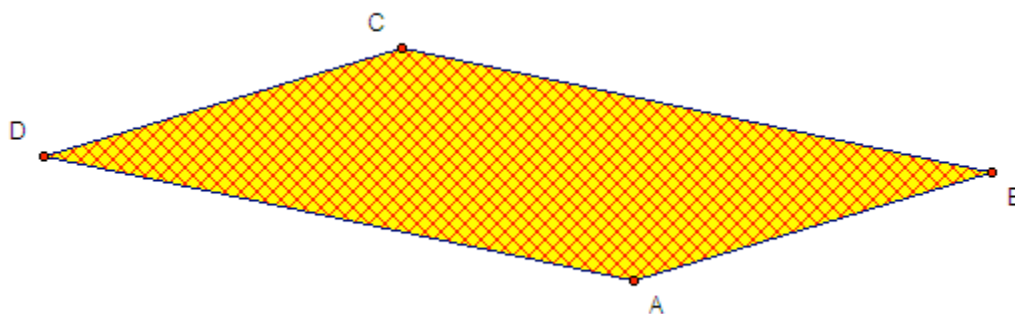
**Step 10:** *Finding the Area of our parallelogram.* a) Using the selection arrow tool , first clear the field, and then select (highlight) the four points *A*, *B*, *C*, and *D* of our parallelogram.



b) Next, select *Construct – Quadrilateral Interior* from the menu bar.



Your Quadrilateral should now look like this:



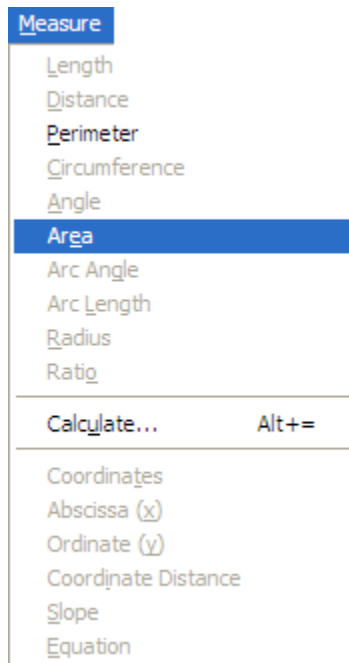
**Reflection Question:**

If you drag point C around on the page, what do you think happens to the Area of your parallelogram?

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c) Now, select *Measure – Area* from the menu bar.



Your area of your parallelogram should now appear in the upper left hand corner of the screen.

**Reflection Questions:**

What is the area of your parallelogram? \_\_\_\_\_

If you drag point C around on your page, what happens to the area of your parallelogram?

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Was your guess before calculating the Area correct? \_\_\_\_\_

Why do you think that this property of Area of your parallelogram occurs?

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**Step 11:** Save your drawing and print for submission (along with this worksheet).