

Opening a Sketch in Geometer's Sketchpad

1. To *open* an existing sketch in Geometer's Sketchpad, select **Open** from the **File** menu.



2. A pop up window will appear. Follow the directions for your particular computer system to get to the file where the existing sketches are stored. Select the desired file (in this case, **Golden Triangles.gsp**) by clicking on the filename then the **Open** button.

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Look in: ଢ	Professional Development 💽 👉 🖻 📸 🛛
Solden Tria	angles
File name:	Golden Triangles Open
Files of type:	Sketchpad Files (*.gsp;*.gs4)

The sketch will open in its own window which you can manipulate like all other windows in Microsoft Windows. To maximize the window, you can double-click on the menu bar at the top of the window.

Sile Edit	eometer's Sketchpad - Golden T Display Construct Transform Mea	T <mark>riangles</mark> sure Graph Window Help	Doubl here.	le-click	
.	🗟 Golden Triangles - Investig	ating Leg Length			<u>^</u>
⊙ <u>\</u> A £	Triangle 1: Construct Triangle 1 Measure Segment BD Measure Segment ED	Triangle 2: Construct Triangle 2 Measure Segment CG	Triangle 3: Construct Triangle 3 Measure Segment JK	Triangle 4: Construct Triangle 4 Measure Segment MN	Triangle 5: Construct Triangle 5 Measure Segment QR
		В	Important!!! Click on the Constru	ict Triangle	

Working with the "Golden Triangles" sketch:

To work with the "Golden Triangles" sketch, you do not need to be familiar with how to use the Geometer's Sketchpad software. Some features that you may need to know about are:

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- □ Action buttons are buttons you can click on that cause a particular action to happen. In this sketch, buttons will either construct the next triangle in the sequence or measure a segment length.
- □ **Cleanup tools** are action buttons that cause certain parts of the sketch to disappear, thus "cleaning up" the sketch.
- □ **Page tabs** are divider tabs that separate different pages in the sketch. In this sketch, there are two pages: Investigating Leg Length and Investigating Dilations.





Part 1: Investigating Leg Length

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Graphing Calculator

2. You will see a table containing lists. Your calculator may contain data in its lists from a previous investigation. If the lists do not contain previous data, you may skip to step 6.

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Generating a Scatterplot of Leg Length vs. Triangle Number Using a

3. To clear this previous data, press STAT.

4. Highlight **ClrList**. Enter the lists that you wish to clear. Press **ENTER**.

5. Press ENTER again.



Algebra 2

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6. Enter the data into the lists. Be sure to press ENTER after each value.

7. Press 2nd [STAT PLOT].

- Use the arrows to select the necessary options. For Plot 1, be sure that the Plot is On and a scatterplot is chosen (first Type). The independent variable (XList) is in L₁ and dependent variable (YList) is in L₂.
- 11. Choose an appropriate window by selecting WINDOW and specifying the appropriate domain and range. Use the arrow keys to move up and down.
- 12. To view the scatterplot, press GRAPH.

Algebra 2 A Golden Idea











Part 1: Investigating Leg Length

Determining a Function Rule for Leg Length vs. Triangle Number Using a Graphing Calculator

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Note: Directions follow for use of a TI-83, TI-83+, or TI-84.

Using Successive Quotients:

m 13

- 1. In the List Editor (Press <u>STAT</u> then press <u>ENTER</u>), copy List 2 into List 3. To do so, use the arrow keys to move the cursor to the List 3 header, then press <u>2nd</u> <u>2</u>. Press <u>ENTER</u>.
- 2. Delete the first element of List 3 by using the arrow keys to select it then press DEL.

keys to select it then press DEL.

3. Delete the last element of List 2 by using the arrow

- L1 L2 **₩**3 3 1 12.33 -----3 4.71 4 2.91 5 1.8 ----- L3 = L 2
- L1 L2 3 L3 12.33 7.62 4.71 2.91 1.8 120555 12.33 7.62 4.71 2.91 1.8 L300=12.33 L1 L2 L3 3 12.33 7.62 4.71 7.62 12055 4.71 2.91 1.8 2.91 1.8 1300=7.62









4. Use the arrow keys to select the List 4 header. We want List 4 to be the quotient of List 3 and List 2. Enter the formula L₄ = L₃/L₂ by pressing 2nd 3, ÷, then 2nd 2. List 4 now contains the successive quotients of the leg lengths, or y-values.

Algebra 2 A Golden Idea

L2	L3	T 1
12.33 7.62 4.71 2.91	7.62 4.71 2.91 1.8	
L4 =L3.	/Lz	
L2	L3	L4 4
12.33 7.62 4.71 2.91	7.62 4.71 2.91 1.8	.61811 .61783 .61856

- Return to the home screen by pressing 2nd MODE or [QUIT]. Calculate the mean value of the successive quotients (List 4) by using Math operations on the Lists. Retrieve the List menu by pressing 2nd STAT then choose the Math options using the arrow key ▶ twice. Use the down arrow key, ♥, to select option 3: mean.
- Enter the list name for which you want to find the mean value, in this case List 4, by pressing 2nd 4. Press ENTER.
- 4:median(5:sum(6:prod(7↓stdDev(moan(L+)

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1 min(2 max(

%⊟mean(



7. Restore the deleted value from List 2. Return to the List Editor (Press <u>STAT</u> then press <u>ENTER</u>), and use the arrow keys to move to the bottom of List 2. Re-enter the value that you deleted.



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2. Press GRAPH then TRACE. Press A to select the function then trace to the prediction using the right and left arrow keys, **()**.

- 1. Press [WINDOW] to enlarge the window. Adjust the settings to make the window large enough to predict with.
- Using the Graph to Make Predictions

9. Enter the appropriate function rule into Y_1 . Press ENTER]. Press GRAPH].

Algebra 2 A Golden Idea











8. Use the mean value to determine the values of *a* and *b*

[Y=]. Clear out any equations by pressing [CLEAR].

in the general form $y = a(b)^x$. Graph the function rule

that you think might "fit" the data well. To do so, press



Using the Table to Make Predictions

1. Press 2nd WINDOW. Enter values for TblStart and Δ Tbl, the value of the *x* increment.

2. Press 2nd GRAPH. Use the up and down arrow keys, A and , to scroll to the desired value.







Part 1: Investigating Leg Length



Determining a Function Rule for Leg Length vs. Triangle Number Using a Microsoft Excel Spreadsheet

1. Enter your data into a blank Excel spreadsheet.

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2. Choose **Chart** from the **Insert** menu.

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3. Select **XY** (Scatter) from the Chart Type selection box then click Next.

Chart Wizard - Step 1 of 4 -	Chart Type 🛛 🛛 🛛 🛛
Standard Types Custom Types Chart type: Column Bar Cine Pie YY (Scatter) Area Doughnut Radar Surface Bubble Stock	Chart sub-type:
Cancel	< Back Next > Einish

4. To select the Data Range, click the **Collapse Dialog** button next to the **Data Range** text box.

Chart Wizard	l - Step 2 of 4 - Chart Source Data	?×
Data Range	Series	
To creal workshe want in	e a chart, click in the Data range box. Then, on the et, select the cells that contain the data and labels you the chart.	
Data range: Series in:	 Rows Columns 	
	Cancel < Back Next > E	jnish



5. Select the cells containing your data then click the **Collapse Dialog** button next to the floating **Chart Source Data** box. You will return to the **Chart Wizard** dialog box.

Trianglo	Log	Chart W	izard - Ste	p 2 of 4 - (Chart Sour	ce Data - D	ata r [2 🗵 –
Number	Leg Length	=Sheet1!\$:C\$3:\$D\$7					F
1	12.33							N hà
2	7.62							
3	4.71							
4	2.91							
L 5	1.8							

6. Click the **Series** tab in order to edit the source data features.

Chart Wizard -	Step 2 of 4	Chart Sourc	e Data	? 🗙
Data Range	Series	* * 3 4 \$D\$7	5 6	• Series1
ĺ	Cancel	< <u>B</u> ack	<u>N</u> ext >	<u> </u>



7. Give "Series 1" an appropriate name. Click inside the **Name** text box and type an appropriate name. In this example, we will use "Leg Length." Click **Next**.

Chart Wizard - Step 2	of 4 - Cha	rt Source Data	? 🔀
Data Range Series			
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10			
6	+		Leg Length
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0 1 ;	2 3	4 5	6
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Leg Length	Name:	Leg Length	<u>.</u>
	<u>x</u> values: V Values:	=Sheet11\$D\$3	3C\$7
Add Remove	<u>1</u> (aldo):		
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Cance		Each Gove	

8. At this point you can customize the chart options, including the **Chart title**, **Value** (*x*) **axis**, and **Value** (*y*) **axis** labels. Enter the pertinent **Chart Options**, including appropriate labels for the x-axis and y-axis. You can also customize the axes, gridlines, legend, and data labels by clicking on the appropriate tab at the top of the dialog box. Click **Next** when you are ready to continue.

Chart Wizard - Step 3 of 4 - Cl	hart Options ?	×
Chart Wizard - Step 3 of 4 - Cl Titles Axes Gridlines Le Chart title: th vs. Triangle Number Value (X) axis: Triangle Number Value (Y) axis: Leg Length (centimeters) Second category (X) axis:	hart Options	
Second value (Y) axis:	0 2 4 6 Triangle Number	
Ca	ancel < Back Next > Finish	



Chart Wizard - Step 3 of 4	- Chart Options	?×
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	Cancel < Back Next >	inish

9. Select the location of the new chart, then click Finish.

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Place chart: -	Place chart:									
	C As new sheet: Chart1									
	As object in: Sheet1	•								
2	Cancel < <u>B</u> ack Next > Einish									



Part 1: Investigating Leg Length

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Determining a Function Rule for Leg Length vs. Triangle Number Using a Microsoft Excel Spreadsheet

1. Click to select your chart. Choose Add Trendline from the Chart menu.

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23 Triangle Number														
24								l .		-	T	T	1	



2. The **Add Trendline** dialog box will appear. Click on the **parent function** for the trendline you wish to graph. If you select **Polynomial** or **Moving Average**, be sure to select the order or period, respectively.

Add Trendlin	ie	
Туре Ор	tions	
Trend/Regres	sion type	
Linear	Logarithmic	Order:
Power	Exponential	Period:
Based on <u>s</u> erie	s:	
Leg Length	~	
		OK Cancel

3. Click on the **Options** tab. Click on the **Display equation on chart** check box. Set any other features that you would like to customize related to your trend line. Click **OK**.

Add Trendline 🛛 🔀
Type Options Trendline name Automatic: Expon. (Leg Length) Custom: Forecast Forecast Forward: O Units Backward: O Units Set intercept = O Units Set intercept = O Units Set intercept = O Display equation on chart Display R-squared value on chart Display R-squared value on chart Display R-squared value on chart O Display R-squared value on chart O Display R-squared value on chart Display R-squared value on chart
OK Lancel



4. Customize the appearance of the equation by double-clicking on the equation. The **Format Data Labels** dialog box will appear. You can change the appearance of the equation, including font, number, and alignment. Click **OK** when you are finished.



Format Data Labels		×
Patterns Font Number	Alignment	
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Auto scale This is a TrueType font. The sam your screen.	ne font will be used	d on both your printer and
	C	OK Cancel



Using the Graph to Make Predictions

1. Double-click the trendline on your chart. The Format Trendline dialog box will appear.



2. Click the **Options** tab. In the **Forecast** text boxes, enter the number of units that you would like to extend the graph either **Forward** or **Backward** beyond your data set. Click **OK**.

Format Trendline	
Patterns Type Options Trendine name Options • Automatic: Expon. (Leg Length) Exponential construction Custom: Option Forecast Unit Backward: O Unit Set intercept = O O Display gquation on chart Display <u>R</u> -squared value on chart	
	OK Cancel

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3. Use the extended graph to estimate the necessary *x*- or *y*-value.

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Part 2: Investigating Dilations

Generating a Scatterplot of Leg Length vs. Dilation Number Using a Graphing Calculator

1. Press STAT. Then press ENTER.

- 2. You will see a table containing lists. Your calculator may contain data in its lists from a previous investigation. If the lists do not contain previous data, you may skip to step 6.
- 3. To clear this previous data, press STAT.

4. Highlight **ClrList**. Enter the lists that you wish to clear. Press **ENTER**.

5. Press ENTER again.







6. Enter the data into the lists. Be sure to press ENTER after each value.

7. Press 2nd [STAT PLOT].

- Use the arrows to select the necessary options. For Plot 1, be sure that the Plot is On and a scatterplot is chosen (first Type). The independent variable (XList) is in L₁ and dependent variable (YList) is in L₂.
- 11. Choose an appropriate window by selecting WINDOW and specifying the appropriate domain and range. Use the arrow keys to move up and down.
- 12. To view the scatterplot, press GRAPH.

Algebra 2 A Golden Idea











Part 2: Investigating Dilations



Using a Graphing Calculator

Note: Directions follow for use of a TI-83, TI-83+, or TI-84.

Using Successive Quotients:

- 1. In the List Editor (Press STAT) then press ENTER), copy List 2 into List 3. To do so, use the arrow keys to move the cursor to the List 3 header, then press 2nd 2. Press ENTER].
- 2. Delete the first element of List 3 by using the arrow keys to select it then press DEL.

3. Delete the last element of List 2 by using the arrow keys to select it then press DEL.

4. Use the arrow keys to select the List 4 header. We want List 4 to be the quotient of List 3 and List 2. Enter the formula $L_4 = L_3/L_2$ by pressing [2nd] 3], (\div) , then [2nd] 2]. List 4 now contains the successive quotients of the leg lengths, or y-values.



L1	L2	L3 3
011275	1.8 2.91 4.71 7.62 12.33	4.71 7.62 12.33
L3(1)=2	.91	





- 5. Return to the home screen by pressing 2nd MODE or [QUIT]. Calculate the mean value of the successive quotients (List 4) by using Math operations on the Lists. Retrieve the List menu by pressing 2nd STAT, then choose the Math options using the arrow key ▶ twice. Use the down arrow key, , , to select option 3: mean.
- Enter the list name of which you want to find the mean value, in this case List 4 by pressing 2nd 4. Press ENTER.

- 7. Restore the deleted value from List 2. Return to the List Editor (Press <u>STAT</u> then press <u>ENTER</u>) and use the arrow keys to move to the bottom of List 2. Re-enter the value that you deleted.
- 8. Use the mean value to determine the values of *a* and *b* in the general form y = a(b)^x. Graph the function rule that you think might "fit" the data well. To do so, press [Y=]. Clear out any equations by pressing [CLEAR].
- 9. Enter the appropriate function rule into Y₁. Press ENTER. Press GRAPH.

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%⊟mean(

5:sum(

4:median(



Plot2 Plot3

Y1=



Algebra 2



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Using the Graph to Make Predictions

1. Press WINDOW to adjust the window. Adjust the settings to enlarge the window enough to make predictions.

Press GRAPH then TRACE. Press ▲ to select the function then trace to the prediction using the right and left arrow keys,





Using the Table to Make Predictions

1. Press 2nd WINDOW. Enter values for TblStart and Δ Tbl, the value of the *x* increment.

2. Press 2nd GRAPH. Use the up and down arrow keys, ▲ and , to scroll to the desired value.







Part 2: Investigating Dilations



Determining a Function Rule for Leg Length vs. Triangle Number Using a Microsoft Excel Spreadsheet

1. Enter your data into a blank Excel spreadsheet.

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1										
2			Dilation Number	Leg Length						
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4			1	2.91			1			
5			2	4.71						
6			3	7.62						
7			4	12.33						
8										

2. Choose **Chart** from the **Insert** menu.





3. Select **XY** (Scatter) from the Chart Type selection box then click Next.

Chart Wizard - Step 1 of 4 -	Chart Type 🛛 🛛 🔀
Standard Types Custom Types Chart type: Column Bar Cine Pie YY (Scatter) Area Doughnut Radar Surface Bubble Stock	Chart sub-type:
Cancel	< Back Next > Einish

4. To select the Data Range, click the **Collapse Dialog** button next to the **Data Range** text box.

Chart Wizard	- Step 2 of 4 - Chart Source Data	? 🗙
Data Range	Series	
To creat workshe want in t	e a chart, click in the Data range box. Then, on the et, select the cells that contain the data and labels you he chart.	
<u>D</u> ata range: Series in:	© Rows O Columns	N
	Cancel < <u>B</u> ack <u>N</u> ext > E	inish



5. Select the cells containing your data then click the **Collapse Dialog** button next to the floating **Chart Source Data** box. You will return to the **Chart Wizard** dialog box.

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	С	D	E	Chart Wizard - Step 2 of 4 - Chart Source Data - Data r ? 🔀
			=Sheet1!\$C\$3:\$D\$7	
	Dilation	Leg		
	Number	Length		
	0	1.8		
	1	2.91		
	2	4.71		
	3	7.62		
	4	12.33		

6. Click the **Series** tab to edit the source data features.

Chart Wizard - Step 2 of 4 - Chart Source Data	? 🗙
Data Range Series	• Series1
Cancel < <u>B</u> ack <u>N</u> ext >	Einish



7. Give "Series 1" an appropriate name. Click inside the **Name** text box and type an appropriate name. In this example, we will use "Leg Length." Click **Next**.

Chart Wizard - Step 2	of 4 - Chart	Source Data	? 🔀
Data Range Series			
	Leg Len	gth	
14		+	
10	•		
6	•		Length
2			
0 1	2 3	4 5	
<u>S</u> eries			
Leg Length	<u>N</u> ame:	Leg Length	<u>.</u>
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Add Remove	<u>v</u> values:	=5166(11)\$0\$5(\$0\$7	
Cancel			Einish

8. At this point you can customize the chart options, including the **Chart title**, **Value** (*x*) **axis**, and **Value** (*y*) **axis** labels. Enter the pertinent **Chart Options**, including appropriate labels for the x-axis and y-axis. You can also customize the axes, gridlines, legend, and data labels by clicking on the appropriate tab at the top of the dialog box. Click **Next** when you are ready to continue.

Chart Wizard - Step 3 of 4 - Ch	iart ()p	tions				?×
Titles Axes Gridlines Lee	gend	1	Data Labels				
Chart title: Leg Length vs. Dilation Numbe			Leg Leng	th vs. D	ilation Nur	nber	
V <u>a</u> lue (X) axis:		14 -					
Dilation Number		12 -					
<u>V</u> alue (Y) axis:	- dt	10 · 8 ·					
Leg Length	9 Le	6			I	_	
Second category (X) axis:	2	4					_
		2:					
Second value (Y) axis:		Č	0 1	2	3	4	ŝ
Dilation Number							
		_					
Cancel < Back Next > Einish							



9. Select the location of the new chart, then click Finish.

Chart Wiza	rd - Step 4 of 4 - (Chart Location		?×
Place chart: -				
	C As new <u>s</u> heet:	Chart1		
	• As object in:	Sheet1		•
2	Cancel	< <u>B</u> ack	Next > Eir	nish





10. You can customize the features of your chart by double-clicking the part that you wish to change. For example, to change the scale of the *x*-axis, double-click the *x*-axis. The **Format Axis** dialog box will appear. Click on the **Scale** tab, then change the major unit. Click **OK**.

Format Axis	2	K
Patterns Scale	Font Number Alignment	
Value (X) axis scale	~	
Auto		
Mi <u>n</u> imum:	0	
Ma <u>x</u> imum:	5	
Major unit:	1	
🗹 Minor unit:	0.2	
Value (Y) axis		
<u>⊂</u> rosses at:	0	
Display <u>u</u> nits:	None 🛛 🗹 Show display units label on chart	
📃 Logarithmic scal	e	
Values in <u>r</u> evers	e order	
🔲 Value (Y) axis cr	rosses at <u>m</u> aximum value	
	OK Cancel	





Part 2: Investigating Dilations



Determining a Function Rule for Leg Length vs. Triangle Number Using a Microsoft Excel Spreadsheet

5. Click to select your chart. Choose **Add Trendline** from the **Chart** menu.

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AB	C D	Location	G	H	1	J	K	L	М	N	0
1		Add Data									
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6. The **Add Trendline** dialog box will appear. Click on the **parent function** for the trendline you wish to graph. If you select **Polynomial** or **Moving Average**, be sure to select the order or period, respectively.

Add Trendlin	ie	
Type Op	tions	
Trend/Regres	sion type	
Linear	Logarithmic	Order:
Power	Exponential	Period:
Based on series	s:	
Leg Length	~	
		OK Cancel

7. Click on the **Options** tab. Click on the **Display equation on chart** check box. Set any other features that you would like to customize related to your trend line. Click **OK**.

Add Trendline 🛛 🛛 🛛 🛛
Type Options Trendline name Automatic: Expon. (Leg Length) Custom: Forecast Forecast Forward: O Units Backward: O Units Set intercept = O Units Set intercept = O Units Set intercept = O Display equation on chart Display R-squared value o
OK Lancel



8. Customize the appearance of the equation by double-clicking on the equation. The **Format Data Labels** dialog box will appear. You can change the appearance of the equation, including font, number, and alignment. Click **OK** when you are finished.



Format Data Labels		X				
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✓ Auto scale This is a TrueType font. The same font will be used on both your printer and your screen.						
		OK Cancel				



Using the Graph to Make Predictions

4. Double-click the trendline on your chart. The Format Trendline dialog box will appear.



5. Click the **Options** tab. In the **Forecast** text boxes, enter the number of units that you would like to extend the graph either **Forward** or **Backward** beyond your data set. Click **OK**.

Format Trendline	
Patterns Type Options Trendline name Automatic: Expon. (Leg Length) © Automatic: Expon. (Leg Length) © Custom: Forecast Eorward: 7 Unit Backward: 0 Units Set intercept = 0 ✓ Display equation on chart Display R-squared value on chart	
	OK Cancel

Teaching Mathematics TEKS Through Technology

6. Use the extended graph to estimate the necessary *x*- or *y*-value.

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