














## Geogebra – Investigating Gradients of Tangents as the Limit of Gradients of Chords.

Follow the instructions below to investigate the fundamentals of differential calculus.

1.		Open a new standard GeoGebra window, showing Graphics and Algebra windows.
2.		Create the function $f(x) = x^2$ by either typing $f(x)=x^2$ or just $x^2$ in the input box.
3.		Create a point on the function graph to the right of the origin at about (1,1) using the Point Tool (you will need to hover over the function until it becomes highlighted before clicking).
4.		Use the Tangent Tool to create a tangent to the function graph at the point you created in step 3. (The Tangent Tool is under the Reflection Tool menu. Select the tool then the Point and then the function graph)
5.		Use the Slope Tool to display the gradient of the Tangent you created in step 4. (The Slope Tool is under the Angle Tool menu. Select the tool then the tangent).
6.	      	<p>Step 5 will have created a new variable 'm' which you can see in the algebra window as well as displayed as a label next to the slope. You can use the value of this variable in a dynamic text window as follows:</p> <p>Use the Text Tool and click in some white space in the graphics window. Type in Edit box: "<i>Gradient of Tangent =</i> " and then select object <input type="text" value="m"/> either by clicking on it in the Algebra window or selecting it from the Object drop-down menu. Check that the correct value is displayed for m in the preview box and click OK.</p> <p>To change the text font and size, select the Move Tool and click on the text to select it. Click on the toggle style menu at the top left of the Graphics window (the small black arrow ) and select desired attributes. Click and drag text to desired position.</p>
7.		Move the point you created in step 3 and see how the gradient and dynamic text changes.
8.		Create another point on the function graph to the right of the first point.
9.		Use the Line Segment Tool (under the Line Tool menu) to create a chord between the two points on the function graph.
10.	 	Use the Slope Tool and Text Tool as in steps 5 and 6 to display the gradient of the chord. (You can change the way both gradient variables display in the window by selecting the variable and changing the Object Properties under 'Show Label' drop-down menu).
11.		Move the right hand point closer and closer to the left hand point and see how the gradient of the chord approaches the gradient of the tangent in the limit. Change the position of the first point on the graph and do this again.
12.		Complete the following sentence in your exercise book: "The gradient of the tangent is the limiting value of _____"
		<p><b>Extension Work:</b></p> <p>Can you use your Geogebra file to see how the gradient of the tangent relates to the x value of the point? (Hint: you may find it useful to create a variable for example 'xvar' which equals the x-value of Point A and then create a dynamic text box with this value displayed). To create this variable just type '<math>xvar=x(A)</math>' in the input box.</p> <p>Complete the following sentence in your exercise book: "For <math>f(x) = x^2</math>, the gradient function <math>f'(x) =</math> _____"</p> <p>Can you change <math>f(x)</math> and investigate different gradient functions?</p>