



### Problem 1 – Graphing Secant and Tangent Lines

**Step 1:** Press  $\boxed{y=}$  and enter the equation  $y = x^2$  into **Y1**.

**Step 2:** Set the viewing window and view the graph by pressing  $\boxed{\text{zoom}}$  and selecting **ZStandard**

**Step 3:** Draw the tangent line to  $y = x^2$  at  $(1, 1)$  by pressing  $\boxed{2nd}$   $\boxed{\text{prgm}}$  (**draw**) and arrow down to select **Tangent**( then  $\boxed{\text{enter}}$ . When prompted to **DRAW TANGENT**, press  $\boxed{1}$   $\boxed{\text{enter}}$ .

1. What is the equation of the tangent line at  $(1, 1)$ ?

2. What is the slope of the line?

**Step 4:** Graph the secant line.

3. What is the slope of the secant line that passes through point  $P(1, 1)$  and point  $Q(3, 9)$ ?

4. Show the work that explains why the secant line through point  $P(1, 1)$  and point  $Q(3, 9)$  is  $y = 4(x - 1) + 1$ .

Press  $\boxed{y=}$  and enter this equation into **Y2** and press  $\boxed{\text{graph}}$ .

5. What could be done to bring point  $Q$  closer to point  $P(1, 1)$ ? What value does the slope need to approach?

**Step 5:** On the  $\boxed{y=}$  screen, change the slope of the secant line to 3.5. Observe the graph, then change the slope to 3 and observe the graph again. Note the intersection points  $P$  and  $Q$ . Repeat one more time, making the slope of the secant line 2.5.

6. As point  $Q$  approaches point  $P$ , what do you notice about the secant and tangent lines?



### Problem 2 – Finding Average Rate of Change

**Step 1:** Turn  $Y_2(x)$  off by pressing  $\boxed{\text{enter}}$  when the cursor is on the = sign next to  $Y_2(x)$  on the **Y=** screen.

**Step 2:** Press  $\boxed{2\text{nd}} \boxed{\text{window}}$  (**tblset**) to set up the table to analyze the function numerically. Change **TblStart** to 1 and  $\Delta$  **Tbl** to 0.1.

**Step 3:** Press  $\boxed{2\text{nd}} \boxed{\text{graph}}$  (**table**) to see the  $x$ - and  $y$ -coordinates of  $Y_1(x)=x^2$ .

The average rate of change of function on an interval  $[a, b]$  is the slope of the secant line containing the points  $(a, Y_1(a))$  and  $(b, Y_1(b))$ .

7. Use the table of values of  $Y_1$  to find the average rate of change of  $Y_1(x)$  on the interval  $[1, 1.1]$ .

### Problem 3 – Finding Instantaneous Rate of Change

The instantaneous rate of a change of a function at a given point is the slope of the tangent line to the function at that point.

If the tangent line is not known, then the secant line slope can be used as an approximation. The calculation from Problem 2 is an example of such an approximation.

8. How can you find an even better estimate of the instantaneous rate of change of  $Y_1(x)$  at  $x = 1$ ?

### Problem 4 – Rectilinear Motion Application

Use your calculator to answer the following questions. For each answer, be sure to include the appropriate units.

Suppose a particle is traveling along a horizontal line such that its position is given by the function  $s(t) = t^3$ ,  $t \geq 0$ , where  $s$  is measured in meters and  $t$  is measured in seconds.

9. What is the average rate of change of the position function from  $t = 2$  to  $t = 4$ ?

10. Estimate the instantaneous rate of change of the position function at  $t = 2$ .



# Secant Lines

## Student Activity

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The velocity of the particle is given by the function  $v(t) = 3t^2$ , where  $v$  is measured in meters per second and  $t$  is measured in seconds.

11. What is the average rate of change of the velocity function from  $t = 2$  to  $t = 4$ ?

12. Estimate the instantaneous rate of change of the velocity function at  $t = 2$ .