Calculus AB 4th Six Weeks Mini-Project Name_____

A. Collecting the Data

You will need three people to collect the data. Then each student will analyze his or her own data. The three jobs are as follows:

1. **Driver** – drives (legally and safely) the car for a total of ten minutes. Reset the trip odometer before you begin to drive. At time t = 0, the car should be completely stopped. After that, you can drive wherever you choose.
2. **Timer** – keeps track of the time as the car is driven and says "time" at the end of every half-minute from zero to ten minutes. Start the clock as soon as the driver begins driving.
3. **Recorder** – records the speed of the car and the distance the car has traveled every half-minute of the trip. You can probably estimate the distance to the nearest half of a tenth.

Record the total distance traveled in the 10 minute trip here: _____

After finishing the trip and collecting the data, each student should fill in the chart below. Notice that there are 21 data points. To compute the third row (miles per minute), you need to convert the data which was collected in miles per hour.

Time (min)	**0.0**	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**
Distance (miles)											
Speed (mi / hour)											
Speed (mi / min)											

Time (min)	**5.5**	**6.0**	**605**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**	**10.0**
Distance (miles)										
Speed (mi / hour)										
Speed (mi / min)										

B. Analyzing the Data – the Distance vs. Time Graph

Graph the distance vs. time. Connect the data points with a curve making it a nice "smooth" function. Attach the graph. Label the axes.

1) Is the Distance vs. Time graph ever decreasing? ____
2) If there is a portion of the graph that is concave up, what does that tell you about the speed of the car?
   _____
3) If there is a portion of the graph that is concave down, what does that tell you about the speed of the car?
   _____
4) If there is a portion of the graph that is perfectly horizontal, what does that tell you about the speed of the car?_____
5) Since you know the total distance traveled, you can compute your **average speed** for the trip. What is it? Also notice that your average speed is the slope of the secant line that connects the starting point and the ending point on the distance vs. time graph.
   Average Speed = _____

C. The Speed vs. Time Graph

Graph the speed (miles per minute) vs. time. Do not connect the data points. Make four copies of this graph, with axes labeled appropriately. (you can xerox it). Attach the graphs.

6) On the first graph of speed vs. time, draw the twenty rectangles that form the Left-hand Riemann Sum. Estimate the area under the graph by calculating the sum. Show your set-up here. Round to 3 decimal places.

Left-hand Riemann Sum =_____

7) On the second graph, draw the twenty rectangles that form the Right-hand Riemann Sum. Estimate the area under the graph by calculating the sum. Show your set-up here. Round to 3 decimal places.

Right-hand Riemann Sum = _____

8) On the third graph, use line segments to connect the data points, forming 20 trapezoids. Compute the Trapezoid Rule to estimate the area under the graph.

Trapezoid Rule = _____

9) On the fourth graph, connect the data points with a "smooth" curve. This time draw a horizontal line through the entire graph that shows the average speed on your trip. (You computed the average speed in Part A). A very important theorem in Calculus (called the Mean Value Theorem) says that for smooth functions there will be at least one time during your ten-minute trip when your average speed is exactly equal to your exact speed (rate of change). How many times did this occur on your trip?

_____

D. Summary Conclusions

10) Speed (velocity) is the derivative (or rate of change with respect to time) of distance (position). Since the distance is always increasing, the speed is always _____.

11) What does the area under the speed vs. time graph represent? Give a short explanation._____
_____

12) Which estimate (Left-hand, Right-hand, or Trapezoid) gave the most accurate answer? _____
What was the percent error in this estimate?_____

13) How could you have improved upon the accuracy of the estimates?_____