# STUDENT PROJECT

## LAMBORGHINI DIABLO VT 6.0 TEST RESULTS

**TABLE 2.6**

| Time (s) | Speed (mph) |
|---|---|
| 0.0 | 0 |
| 2.1 | 30 |
| 2.9 | 40 |
| 3.6 | 50 |
| 4.3 | 60 |
| 5.6 | 70 |
| 6.7 | 80 |
| 7.9 | 90 |
| 8.2 | 100 |
| 9.7 | 110 |
| 11.8 | 120 |
| 13.7 | 130 |

Lamborghini Acceleration Data. The graph in Fig. 2.64 represents data from an acceleration test of a 2000 Lamborghini Diablo VT 6.0. From a standing start, the Lamborghini accelerated for several seconds. The times (in seconds) at which the Lamborghini reached certain speeds (in miles per hour) were recorded. The data collected were obtained from *Car and Driver*, July 2000, p. 93, and are summarized in Table 2.6. To obtain Fig. 2.64, the data were graphed and consecutive data points joined by a line segment.

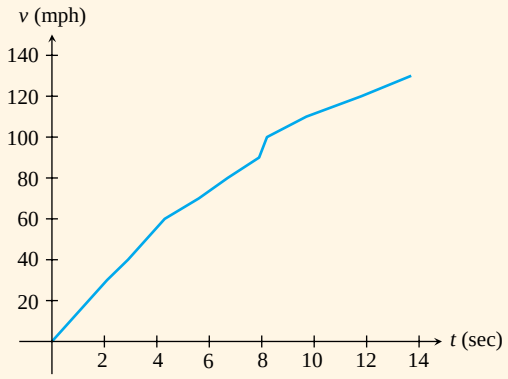
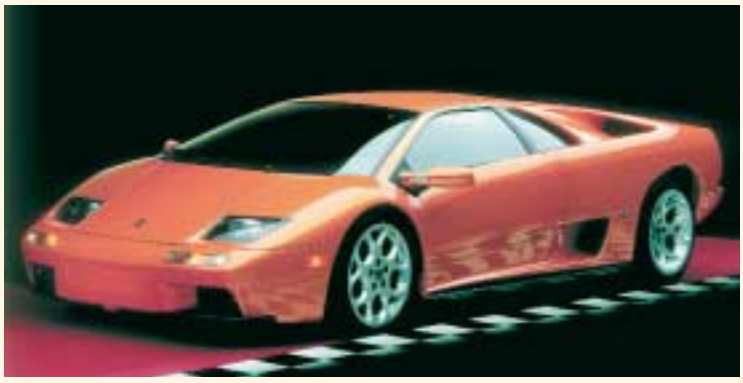



FIGURE 2.64 2000 Lamborghini Diablo VT 6.0 Model Test Results.



In this project, we will first estimate the distance $d(t)$ traveled by the Lamborghini during the first $t$ seconds of the test, for $t = 0, 2.1, 2.9, \ldots, 13.7$. We will do so by estimating the distance traveled by the car in the time between two data points and keeping a running total of the distance traveled. We will also compute the average acceleration for the Lamborghini over the time intervals between consecutive velocity readings.

To get started, let's estimate the distance the Lamborghini traveled during the time interval from 5.6 to 6.7 seconds. During this 1.1-second time interval, the car accelerated from $v(5.6) = 70$ mph to $v(6.7) = 80$ mph. It is reasonable to assume

that the average speed during this time was

$$\frac{70 + 80}{2} = 75 \text{ mph.}$$

Now, 1.1 seconds is the same as 1.1/3600 hours. Thus, during this 1.1 seconds of the test from $t = 5.6$ to $t = 6.7$, the Lamborghini traveled approximately

$$(75 \text{ miles/hour})\,(1.1/3600 \text{ hours}) \approx 0.0229 \text{ miles.} \tag{1}$$

In a similar way, we can approximate the distance traveled by the Lamborghini during the time between any two consecutive data points. By adding these distances, we can find the total distance covered by the car during the test.

**PROBLEM 1** Using the ideas just outlined, estimate the position $x(t)$ of the Lamborghini at times 0, 2.1, 2.9, 3.6, . . . , 13.7. How far did the Lamborghini travel up to the time that its velocity was 130 miles per hour? Using the results of these calculations, prepare a graph of the position $x(t)$ against time $t$.

**PROBLEM 2** Give a geometric interpretation of the computations used in Problem 1. First, take another look at (1). We can rewrite the left side of this equation as

$$\frac{v(5.6) + v(6.7)}{2} \cdot (6.7 - 5.6)/3600.$$

This expression may be interpreted as the area of a certain trapezoid that can be drawn on the velocity graph. (For this it is helpful to think of the units on the $t$-axis as hours, so all of the $t$-axis labels should be divided by 3600). Draw the appropriate trapezoid on the graph and carefully explain the connection between the area of this trapezoid and the distance traveled. Finally, relate the numerical value of $x(13.7)$ to an area associated with the velocity graph.

Finding the Acceleration. In Problem 3 we will approximate the Lamborghini's acceleration as a function of time. The average acceleration during a time interval $[t_1, t_2]$ is defined as the

$$\frac{\text{change in speed}}{\text{change in time}} = \frac{v(t_2) - v(t_1)}{t_2 - t_1}.$$

**PROBLEM 3** Compute the average acceleration of the Lamborghini on the time intervals $[0, 2.1]$, $[2.1, 2.9], \ldots, [11.8, 13.7]$. Using the velocity graph, give a geometric interpretation of these computed average accelerations. Explain your interpretation carefully.

**PROBLEM 4** Find the midpoint of each of the intervals $[0, 2.1]$, $[2.1, 2.9], \ldots,$ $[11.8, 13.7]$. Let $t_m$ denote a typical midpoint. Explain why it is reasonable to use the average accelerations computed in Problem 3 as estimates of the actual acceleration at times $t = t_m$. Using these estimates, sketch a graph of the acceleration $a(t)$ against $t$. Could you have predicted the rough shape of this acceleration graph by looking at the velocity graph?