Jaguar XK8 Test Results

The table below shows data from an acceleration test of a 1997 Jaguar XK8 (list price: $78,308), as reported in *Car and Driver*, November 1996. For example, 3.7 seconds into the test, the Jaguar was doing 40 miles per hour.

t (sec)	0.0	2.5	3.7	5.2	6.9	8.8	11.2	14.1	17.5	22.0	28.5	36.7	49.6
v (mph)	0	30	40	50	60	70	80	90	100	110	120	130	140

Problem 1. Plot the data from the table on a graph, and join the points with a smooth curve. What quantity is represented by the area between your curve and the t axis? You will need concepts from Calculus to justify your answer fully. The rule "velocity $\times$ time = distance" is valid only when velocity is constant, not when the motion is accelerated.

Problem 2. The *average acceleration* during a time interval $[t_1, t_2]$ is the quantity

$$\frac{\Delta v}{\Delta t} = \frac{v(t_2) - v(t_1)}{t_2 - t_1}.$$

Compute the average acceleration on each time interval $[0, 2.5]$, $[2.5, 3.7]$, ..., $[36.7, 49.6]$. Refer to the graph you drew for Problem 1, and interpret the computed average accelerations geometrically. Find the midpoint of each time interval $[0, 2.5]$, $[2.5, 3.7]$, ..., $[36.7, 49.6]$. For each midpoint t_{mid}, estimate the acceleration $a(t_{\text{mid}})$ by the average acceleration in that interval. Plot a graph of the estimated acceleration function. Is the acceleration increasing with time, or is it decreasing?

Problem 3. Use the data to calculate as accurately as you can the distance travelled by the Jaguar during each of the clock intervals $[0, 2.5]$, $[2.5, 3.7]$, etc. How far has the Jaguar gone by the end of the test (i.e. after 49.6 sec)? Explain your method, and explain *why* you believe it to be accurate. Is your approximation an overestimate, or an underestimate, of the actual distance? [Your answer to Problem 2 may be of help here.]

Problem 4. An important statistic for car enthusiasts is the time required to cover a quarter mile from a standing start. Use your results from Problems 2 and 3 to estimate this time to the nearest 0.1 sec.