6. [12 points] The rate \( q(t) \) at which cars passed through the intersection of Main Street and Huron after a football game is presented in the table below.

<table>
<thead>
<tr>
<th>( t ) (in minutes after the game ended)</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>( q(t) ) (in cars per minute)</td>
<td>10</td>
<td>15</td>
<td>19</td>
<td>21</td>
<td>20</td>
<td>17</td>
<td>13</td>
</tr>
</tbody>
</table>

a. [4 points] What is the meaning of \( \int_{0}^{120} q(t) \, dt \)? Using a left Riemann sum and \( n = 6 \), estimate \( \int_{0}^{120} q(t) \, dt \). (Write out the terms of your sum.)

Solution: The expression \( \int_{0}^{120} q(t) \, dt \) gives the total number of cars that passed through the intersection in the first two hours after the game. A left-hand approximation with 6 subdivisions is given by

\[
(20)(10 + 15 + 19 + 21 + 20 + 17) = 2040 \text{ cars}.
\]

b. [2 points] Write an expression for the average rate at which cars passed through the intersection for the first two hours after the game ended.

Solution: The average rate at which cars passed through the intersection during this time period is given by \( \frac{1}{120} \int_{0}^{120} q(t) \, dt \).

c. [3 points] Estimate \( q'(30) \).

Solution: The best estimate we can get from the table is

\[
q'(30) \approx \frac{19 - 15}{40 - 20} = 0.2 \text{ cars per minute per minute}.
\]

d. [3 points] If \( Q(t) \) denotes the total number of cars that have passed through the intersection \( t \) minutes after the game ended, find and interpret \( Q'(60) \).

Solution: We can read \( Q'(60) \) from the table. We have \( Q'(60) = 21 \) and indicates that one hour after the game, approximately 21 additional cars would pass through the intersection in the next minute.