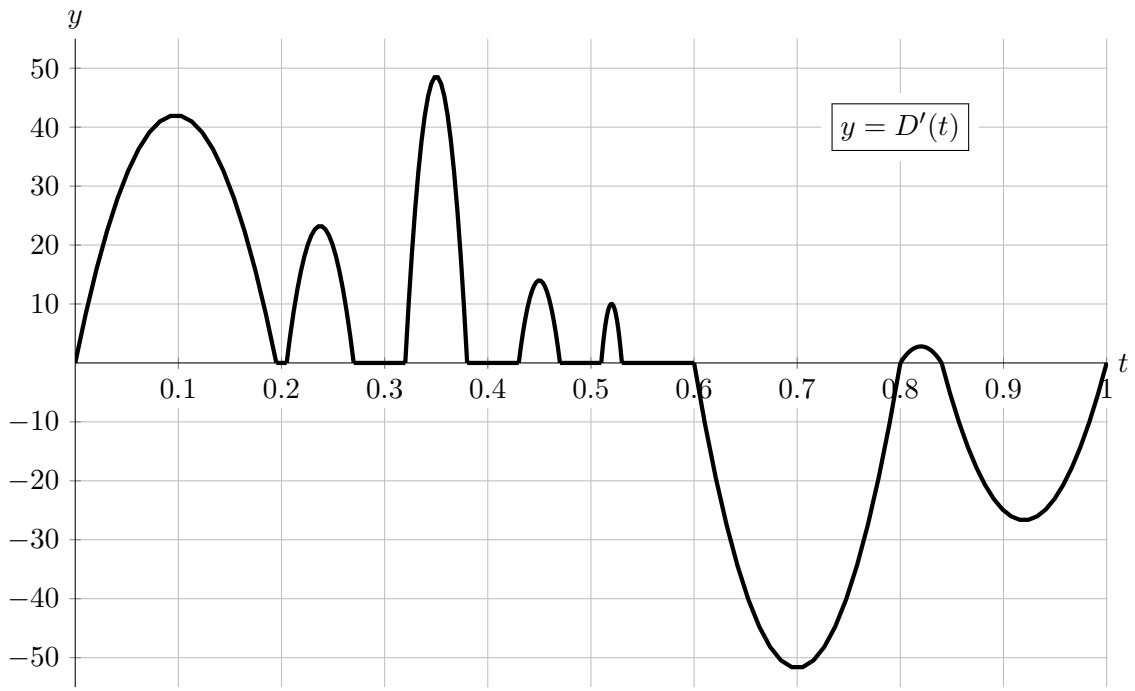
7. [9 points] A pizza delivery driver works for a pizzeria on Main Street, which is a long, straight road. The driver tracks her location with her phone while driving a route on Main Street. Let $D(t)$ be her distance from her pizzeria, in miles, at time t hours after noon. Below is a portion of the graph of $D'(t)$, the **derivative** of $D(t)$.



a. [2 points] On which of the following intervals of t is the driver getting closer to her pizzeria for the entire interval? Give your answer as a list of one or more intervals, or write NONE.

$(0.1, 0.2)$ $(0.2, 0.3)$ $\boxed{(0.6, 0.8)}$ $(0.8, 1)$

Solution: The driver is getting closer to her pizzeria only when $D'(t)$ is *negative* (i.e. her distance to the pizzeria is *decreasing*). The only one of these intervals on which $D'(t)$ is always negative is $(0.6, 0.8)$.

b. [3 points] The speed limit in the driver's hometown is 40 miles per hour. How many different times does she *begin* to drive over the speed limit?

Solution: She *begins* to drive over the speed limit at the t-values where $|D'(t)|$ goes from being smaller than 40 to being larger than 40. The t-values at which this happens are:

- right before $t = 0.1$,
- between $t = 0.3$ and $t = 0.4$,
- right before $t = 0.7$.

Therefore she begins to drive over the speed limit at 3 different times.

c. [2 points] At which of the following times is the driver farthest from her pizzeria? Write the one best answer.

$t = 0.1$ $t = 0.35$ $t = 0.5$ $\boxed{t = 0.6}$ $t = 0.7$

Solution: Notice that for $0.1 \leq t \leq 0.7$, the function $D'(t)$ starts out having only non-negative values, and then switches to having only non-positive values. Consider some time t. As long as there are more positive values of $D'(t)$ yet to come, the driver will get farther from the pizzeria than she is now! Of course, once the values of $D'(t)$ are negative, she's now going towards the pizzeria, so her furthest point was in the past. The last point where $D'(t)$ has only ever been non-negative is $t = 0.6$, and so this is the time at which she is farthest from the pizzeria.

d. [2 points] Write the number of the the sentence below that best describes the driver's behavior on the interval $0.2 \leq t \leq 0.5$.

1. *The driver keeps returning to the pizzeria to pick up more pizza.*
2. *The driver is driving on a highway without any traffic.*
3. *The driver stops at a series of red lights.*
4. *The driver is driving in circles, looking for a place to park.*

Solution: Let us consider what a graph for each of these options might look like.

1. For this option, we would expect to see $D'(t)$ going from positive to negative over and over again, since she would be leaving ($D'(t) > 0$) and then returning to ($D'(t) < 0$) the pizzeria multiple times.
2. For this option, we would expect $D'(t)$ to never be 0, since she wouldn't stop on the highway unless there is traffic.
3. For this option, we would expect $D'(t)$ to keep switching from positive (driving forward) to 0 (stopped at a light).
4. For this option, we would expect to see $D'(t)$ going from positive to negative over and over again, since she would be driving both towards and away from the pizzeria as she circles around.

Of these descriptions, only number 3 matches the graph, and so this is our answer.