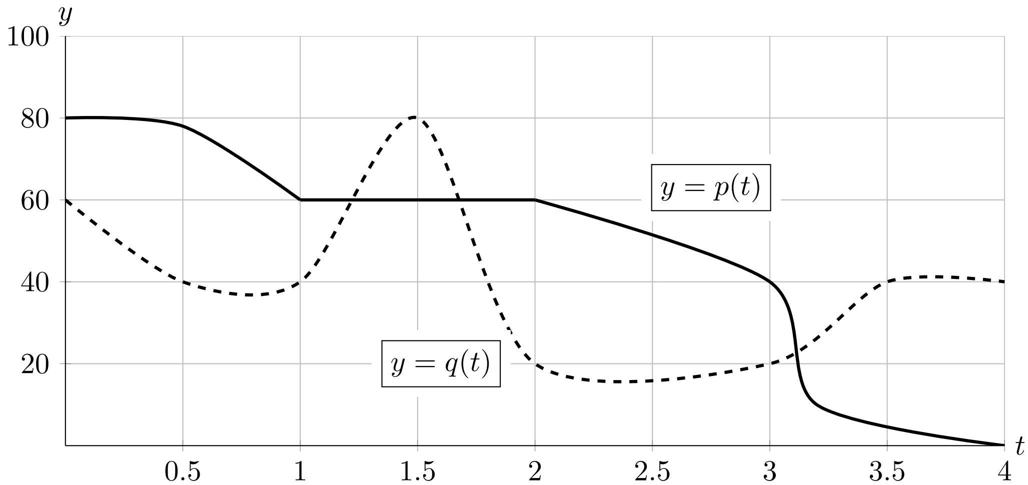
This problem continues the investigation of Xanthippe's donuts.

4. [10 points] For your convenience, the graphs of $p(t)$ and $q(t)$ are reprinted below. Recall:

- The rate, in donuts per hour, at which Xanthippe makes donuts t hours after 7 am is modeled by the function $p(t)$.
- The rate, in donuts per hour, at which customers purchase donuts t hours after 7 am is modeled by the function $q(t)$.
- Assume that at 7 am, Xanthippe begins with no donuts in stock.



a. [4 points] Estimate the total number of donuts produced by 10 am using a right-hand Riemann sum with two equal subintervals. Be sure to write down all the terms in your sum. Is your answer an underestimate or overestimate?

Solution: Each subinterval has width $\Delta t = 1.5$. Therefore, a right-hand Riemann sum with two equal subintervals is $\int_0^3 p(t)\,dt \approx p(1.5)\cdot 1.5 + p(3)\cdot 1.5 = 60\cdot 1.5 + 40\cdot 1.5$

Answer: donuts produced by 10 am $\approx$ **150**

This is an (circle one) OVERESTIMATE $\boxed{\text{UNDERESTIMATE}}$

b. [4 points] The number of donuts in stock t hours after 7 am is modeled by the function $s(t)$. Estimate the t-values for all critical points of $s(t)$ in the interval $0 < t < 4$, and estimate all values of t in the interval $0 < t < 4$ at which $s(t)$ has a local extremum. For each answer blank write NONE if appropriate. You do not need to justify your answers.

Solution: We know $s'(t) = p(t) - q(t)$. Since $p(t)$ and $q(t)$ are defined on $0 < t < 4$, we only need to find where $p(t) - q(t) = 0$. In other words, where $p(t) = q(t)$. From the graph, we can see that $s(t)$ goes from positive to negative at $t = 1.2$ and $t = 3.1$ and from negative to positive at $t = 1.7$.

Answer: Critical point(s) at $t =$ **1.2, 1.7, 3.1**

Local max(es) at $t =$ **1.2, 3.1** Local min(s) at $t =$ **1.7**

c. [2 points] At what time is the number of donuts that Xanthippe has in stock the greatest? Round your answer to the nearest half hour. You do not need to justify your answer.

Answer: **10:00 am**