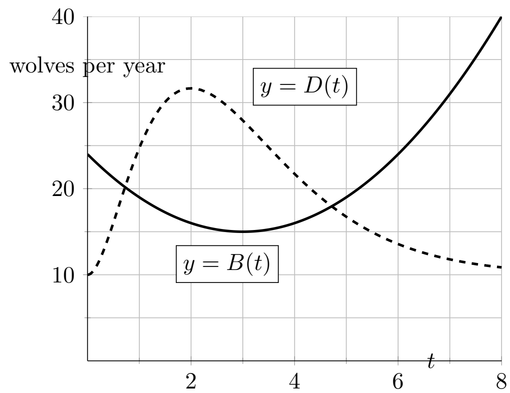
5. [8 points] The wolf population in the Upper Peninsula of Michigan (UP) has been closely monitored since recovering from near extinction several decades ago.

- Let $B(t)$ be the rate, in wolves per year, at which wolves were being born in the UP t years after January 1st, 2010.
- Let $D(t)$ be the rate, in wolves per year, at which wolves were dying in the UP t years after January 1st, 2010.

Suppose that the graphs of $B(t)$ (solid) and $D(t)$ (dashed) are as shown below.



Assume that no wolves migrate in and out of the UP. That is, any wolf born in the UP remains there, and no wolves born elsewhere travel to the UP. Also, let W_0 denote the number of wolves in the UP on January 1st, 2010.

In parts **a.** and **b.**, your mathematical expressions may involve $B(t)$, $D(t)$, their derivatives, W_0, and/or definite integrals.

a. [2 points] Write an expression that represents the total number of wolves born in the UP in the year 2017.

Answer: $\int_7^8 B(t)\ dt$

b. [3 points] Write an expression that represents the total number of wolves living in the UP on January 1st, 2018.

Answer: $W_0 + \int_0^8 B(t) - D(t)\ dt$

c. [1 point] Is there a time $t > 0$ when the number of wolves in the UP was equal to W_0? If so, estimate the first such time; if not, write NONE.

Answer: $t \approx$ 1.3

d. [2 points] Estimate the time(s) t, for $0 \leq t \leq 8$, when the population of wolves in the UP was the smallest.

Answer: $t \approx$ 4.7