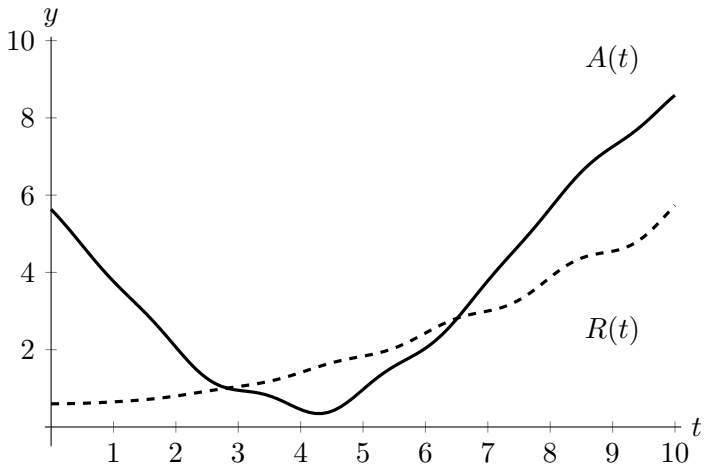
8. [11 points] A tank contains 30 gallons of water. Beginning at 11 am, water is pumped in and out of the tank. Let $A(t)$ be the rate, in gallons per minute, at which the water is added into the tank t minutes after 11 am. Similarly, let $R(t)$ be the rate, in gallons per minute, at which the water is removed from the tank t minutes after 11 am. The graphs of the functions $A(t)$ (solid line) and $R(t)$ (dashed line) for $0 \leq t \leq 10$ are shown below.



a. [2 points] For which values of t is the total amount of water in the tank decreasing? Estimate your answer.

Solution:

Answer: Approximately for $2.75 \leq t \leq 6.5$.

b. [1 point] At what time $0 \leq t \leq 10$ does the tank have the least amount of water?

Solution:

Answer: $t = 0$.

In parts **c**. and **d**., give a mathematical expression that may involve $A(t)$, $R(t)$, their derivatives, and/or definite integrals.

c. [2 points] Find an expression for the total amount of water, in gallons, that was removed from the tank between 11:02 am and 11:05 am.

Solution:

Answer: $\int_2^5 R(t)dt$.

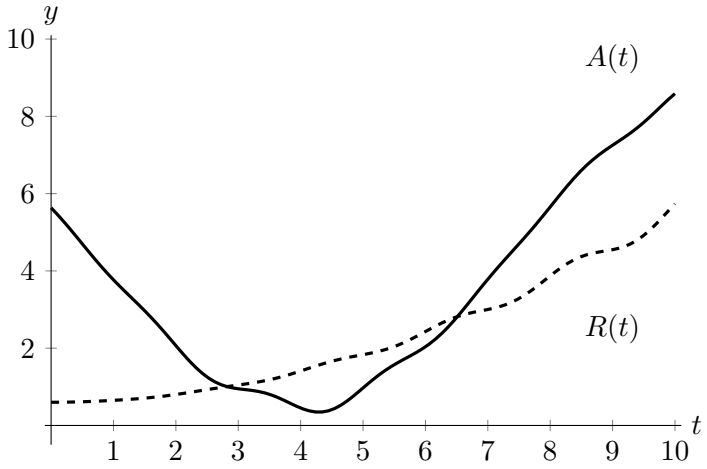
d. [4 points] Find an expression for the amount of water, in gallons, in the tank at 11:10 am.

Solution:

Answer: $30 + \int_0^{10} A(t) - R(t)dt$.

Problem continues on the next page

For your convenience, the graphs of $A(t)$ and $R(t)$ for $0 \le t \le 10$ are reprinted below.



e. [2 points] Suppose that there are 30 gallons of water in the tank at 11:20 am. Which of the following graphs could be the graph of $A(t)$ and $R(t)$ for $0 \le t \le 20$ in this case? Circle the *one* best answer.

Solution: