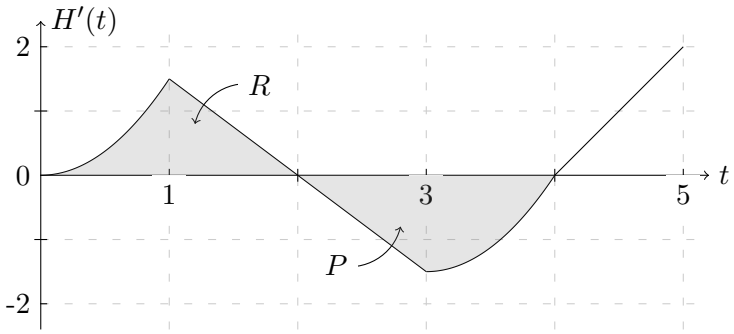
11. [10 points] Perhaps sensing that the end is near, Steph is preparing her eventual legacy. While experimenting with an accelerant called Equinate, Steph found that she could alter its *heat of combustion* by aging the Equinate in barrels. Let $H(t)$ be the heat of combustion of Equinate, measured in hundreds of millions of Joules per kilogram, after the Equinate has been aged for t years. A graph of the derivative $H'(t)$ is below; note that $H'(t)$ is linear for $1 < t < 3$ and $4 < t < 5$. Let $R > 0$ be the area of the region between the t-axis and the graph of $H'(t)$ for $0 \le t \le 2$. Let $P > 0$ be the corresponding area for $2 \le t \le 4$.



a. [3 points] The heat of combustion of Equinate, after aging for 5 years, is 200 million J/kg. What is the heat of combustion of Equinate that has not been aged at all? Your answer may include R and P.

Solution: The answer is $1 - R + P$ hundred million J/kg.

b. [3 points] Steph is storing four barrels of Equinate in the ShamCorp basement. Barrel A has not been aged; barrel B has been aged for 2 years; barrel C has been aged for 4 years; and barrel D has been aged for 5 years. In the spaces provided, list the barrels A, B, C, and D in **increasing** order of heat of combustion.

C < A < D < B

c. [4 points] At some time between 4 and 5 years of aging, the heat of combustion of Equinate is the same as if it had not been aged at all. After how many years of aging does this occur? Your answer may include R and P.

Solution: This occurs after $4 + \sqrt{P - R}$ years of aging.