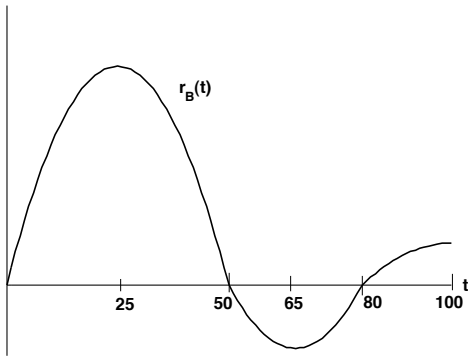
8. [12 points] Suppose the functions $r_A(t), r_B(t)$, and $r_C(t)$ give the rate of population growth in millions of people per year t years after 1900 for Country A, Country B, and Country C, respectively.

a. [4 points] In 1900, Country A's population was 2.3 million people. Write an expression for the function $P_A(Y)$, Country A's population in millions of people Y years after 1900.

Solution:

$$P_A(Y) = \int_0^Y r_A(t)dt + 2.3$$

b. [4 points] Below is a graph of the rate of population growth for Country B, $r_B(t)$. Estimate the year in which Country B's population reached its greatest level and the year in which it reached its lowest level.



Year of greatest population: **1950** Year of lowest population: **1900**

c. [4 points] Suppose $r_C(t) = te^{-0.05t^2}$. During the years 1900-2000, what is the average growth rate for Country C? You must show enough work to justify your answer and include units to receive full credit on this problem. Write your final answer in the space provided below.

Solution: Average rate of growth $= \frac{1}{100}\int_0^{100} r_C(t)dt = \frac{1}{100}\int_0^{100} te^{-0.05t^2}dt = 0.1$.

Average growth rate: **0.1 millions people per year**