1. According to Fick’s law, the diffusion of a solute across a cell membrane is given by

\[ c'(t) = \frac{KA}{V} [C - c(t)] \quad (1) \]

where \( A \) is the area of the cell membrane, \( V \) is the volume of the cell, \( c(t) \) is the concentration inside the cell at time \( t \), \( C \) is the concentration outside the cell. Here \( C, k \) and \( A \) are positive constants. From the constraint (1) on how \( c \) changes, we will derive a formula for \( c(t) \).

   a) Given constants \( u_0 \) and \( b \), compute the derivative \( u'(t) \) of the function \( u(t) = u_0 e^{bt} \) and show that \( u'(t) = bu(t) \). (In fact, if \( u'(t) = bu(t) \), then \( u(t) \) must have this form.) One can evaluate \( u_0 \) by setting \( t = 0 \), to get: \( u_0 = u(0) \)

   b) Let \( u(t) = C - c(t) \). From (1), write a new differential equation in terms of \( u \) and \( u' \).

   c) Solve that new differential equation to find a formula for \( u(t) \).

   d) From this formula for \( u(t) \), derive a formula for \( c(t) \). We assume that \( c(t) \) is defined for \( t \) in some interval containing \( 0 \). (It can be shown that every solution of (1) has this form.)
2. The graph below shows the rate of inhalation of oxygen (in liters per minute) by a person riding a bicycle very rapidly for 10 minutes. Estimate the total volume of oxygen inhaled in the first 20 minutes after the beginning of the ride. Use rectangles with widths of 1 minute.