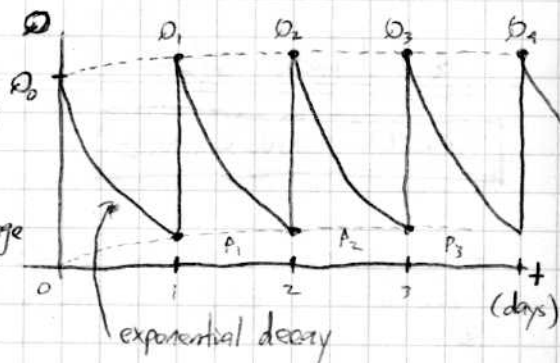


ex (9.2.25)

Atenolol is given to lower blood pressure on a daily basis (50 mg / per day). The amount of drug in the body is $Q(t)$ where t is time in ~~days~~ ^{hours}. Assume an initial dose $Q_0 = 50$ mg is given at $t = 0$.

a) the half-life of atenolol is 6.3 hours. Find the ~~amount~~ ^{percentage} of drug in the system after the initial 24 hour period.



assume exponential decay: $Q(t) = Q_0 e^{-kt}$

half-life means $\frac{1}{2}Q_0$ has decayed away after 6.3 hours $\rightarrow$ solve for k

$$\frac{1}{2}Q_0 = Q_0 e^{-k \cdot 6.3} \rightarrow k = -\frac{\ln(0.5)}{6.3} \approx 0.11 \Rightarrow Q(t) = Q_0 e^{-0.11t}$$

$$\text{after 24 hours, } Q(24) = Q_0 e^{-(0.11)(24)} \approx 0.07 Q_0 \Rightarrow \boxed{\text{so } \sim 7\% \text{ of the original dose is left}}$$

b) Find an expression for $Q_1, Q_2, Q_3, \dots$. Find a general expression for Q_n .

$$Q_0 = 50 \text{ mg (let's call } Q_0 \text{ the dose given daily)}$$

$$Q_1 = \text{new dose} + \text{leftover from first dose} = Q_0 + Q_0 \cdot 0.07 = Q_0 (1 + 0.07)$$

$$Q_2 = \text{new dose} + \text{leftover from first two doses} = Q_0 + (0.07)(Q_0 + Q_0 \cdot 0.07) = Q_0 (1 + 0.07 + 0.07^2)$$

10x (cont.)

D_3 = new dose + leftover of previous doses

$$= D_0 + (0.07)(D_0 + D_0 \cdot 0.07 + D_0 \cdot 0.07^2)$$

$$= D_0 (1 + 0.07 + 0.07^2 + 0.07^3)$$

→ see a general pattern: $D_N = \sum_{n=0}^N D_0 (0.07)^n = \boxed{\frac{D_0 (1 - (0.07)^{N+1})}{1 - 0.07}} \text{ mg}$

(where $D_0 = 50 \text{ mg}$)

- 5 what happens as a patient takes the drug indefinitely?
(i.e. what is the concentration in their system ~~when~~ after they take their daily dosage?)

$$D = \sum_{n=0}^{\infty} D_0 (0.07)^n = \frac{D_0}{1 - 0.07} \approx \boxed{53.8 \text{ mg}}$$

- 7 find an expression for $P_1, P_2, P_3, \dots$ (the quantity in their system right before taking the new dose)

$$P_1 = 0.07 D_0$$

$$P_2 = (0.07)(D_0 + 0.07 D_0) = D_0 \cdot 0.07 + D_0 (0.07)^2 = D_0 (0.07 + 0.07^2)$$

following this pattern $P_N = D_0 (0.07 + 0.07^2 + \dots + 0.07^N)$

$$= 0.07 \cdot D_0 (1 + 0.07 + 0.07^2 + \dots + 0.07^{N-1})$$

$$\boxed{= 0.07 D_0 \cdot \frac{1 - 0.07^N}{1 - 0.07}}$$