

Homework 2 solutions

1. (a)  $T_c = \frac{V_0}{Q_0} = \frac{5 \text{ L}}{5.6 \text{ (L/min)}} \approx 0.89 \text{ min}$

(b)  $\langle T_c \rangle = \frac{\sum_i T_i Q_i}{\sum_i Q_i} = \frac{\sum_i (V_i/Q_i) Q_i}{\sum_i Q_i} = \frac{\sum_i V_i}{\sum_i Q_i} = \frac{V_0}{Q_0}$

2. (a)  $-P^* + P_1 = Q_1 R_1 \Rightarrow Q_1 + Q_2 = Q = (-P^* + P_1) \left( \frac{1}{R_1} + \frac{1}{R_2} \right)$   
 $-P^* + P_1 = Q_2 R_2$

$Q_1 = (-P^* + P_1) \cdot \frac{1}{R_1}$   
 $Q_2 = (-P^* + P_1) \cdot \frac{1}{R_2}$

$\frac{Q_2}{Q} = \frac{1}{R_2} \left( \frac{1}{R_1} + \frac{1}{R_2} \right)^{-1} = 2/3$

$R_1 = 6 \rightarrow \frac{1}{R_2} \left( \frac{1}{6} + \frac{1}{R_2} \right)^{-1} = 2/3$

$R_2 \left( \frac{1}{6} + \frac{1}{R_2} \right) = \frac{3}{2}$

$\frac{R_2}{6} = \frac{1}{2} \rightarrow R_2 = 3 \frac{\text{mm Hg}}{\text{L/min}}$

(b)  $R_{\text{tot}} = \left( \frac{1}{R_1} + \frac{1}{R_2} \right)^{-1} = \left( \frac{1}{6} + \frac{1}{3} \right)^{-1} = 2 \frac{\text{mm Hg}}{\text{L/min}}$

$P^* = 100 - (4 \text{ L/min}) (2 \text{ mmHg/L/min})$

$P^* = 92 \text{ mm Hg}$

(c)  $V = 7.5 \text{ L}, P^* = 92 \text{ mm Hg}$

$C^* = \frac{V - V_d}{P^*} = \frac{2.5 \text{ L}}{92 \text{ mm Hg}} \approx 0.027 \text{ L/mmHg}$

(d)  $R_3 = \frac{\Delta P}{Q} = \frac{P^* - P_2}{Q} = \frac{92 - 50}{4} = \frac{42}{4} = 10.5 \text{ mm Hg/L/min}$

(e)  $\dot{W} = Q_0 P = (50 \text{ mm Hg}) (4 \text{ L/min}) = 200 \text{ mm Hg} \cdot \text{L/min}$