Calculating Time Constants and Expiratory Time
Use 3 time constant to calculate the expiratory time

Time Constant = The length of time it takes for the lung units to fill or empty. This means that time constant equals the length of time in seconds required for lungs units to inflate and deflate to a certain % of their total volume.

Formulas to know:

Measured Inspiratory flow needs to be converted to L/cm$H_2$0 second

Inspiratory flow per second = (L/min / 60 seconds)

R_{aw} *= (PIP – Pplat)*

Time Constant *= (R_{aw} / flow L/cm$H_2$0)*

Expiratory time *= Time Constant x 3* ***Example****: 3 converted to 0.3*
~See Figure 1~

Note: Inspiratory flow is measured in L/cmH_2O minute. You will need to convert this to L/cmH_2O second. Divide flow by 60 seconds to give you L/cmH_2O second

Example: Inspiratory flow = 40 L/cm$H_2$0 minute, PIP 20, and Pplat 15.

Step 1: Convert flow: (40 L/cm$H_2$0 minute / 60 seconds) = 0.66 or 0.7

Step 2: R_{aw} = (PIP – Pplat) Example: (20 cmH_2O –15 cmH_2O) = 5 cm$H_2$0

Step 3: (R_{aw} / flow) Example: (5 / 0.7) = 7.14 or 7

Step 4: Time Constant = Example: (7 x 0.3) = 2.1 seconds E time

Time Constant Method to determine expiratory time:

0.1 sec = 1 time constant means it takes 63% of the volume to be inhaled or exhaled

0.2 sec = 2 time constant means it takes 86% of the volume to be inhaled or exhaled

0.3 sec = 3 time constant means it takes 95% of the volume to be inhaled or exhaled

0.4 sec = 4 time constant means it takes 98% of the volume to be inhaled or exhaled

0.5 sec = 5 time constant means it takes 100% of the volume to be inhaled or exhaled

Practice Answers:

1. Given a Inspiratory flow of 40 L/cmH_2O minute, PIP 35 and Pplat 20, calculate the following based on: 3 Time Constant.

a. Inspiratory flow 40 L/cmH_2O minute
   I. **40 L/cmH_2O minute / 60 seconds = 0.66 or 0.7**

b. PIP 35 cmH_20; Pplat 20 cmH_20
   I. R_{aw} = 15 cmH_20

c. Time Constant Calculation: (R_{aw} / flow L/cmH_2O second)
   I. 15 / 0.7 = 21
   II. 21 x 0.3 Times Constant = 6
      a) **Expiratory time needed** = 6 seconds

2. Given a Inspiratory flow of 30 L/cmH_2O minute, PIP 20 and Pplat 16, calculate the following based on: 3 Times Constant.

a. Inspiratory flow 30 L/cmH_2O minute
   I. **30 L/cmH_2O minute / 60 seconds = 0.5**

b. PIP 20 cmH_20; Pplat 16 cmH_20
   I. R_{aw} = 4 cmH_20

c. Time Constant Calculation: (R_{aw} / flow L/cmH_2O second)
   I. 4 / 0.5 = 8
   II. 8 x 0.3 Times Constant = 2.4
      a) **Expiratory time needed** = 2.4 seconds

3. Given a Inspiratory flow of 50 L/cmH_2O minute, PIP 25 and Pplat 17, calculate the following based on: 3 Times Constant.

a. Inspiratory flow 50 L/cmH_2O minute
   I. **50 L/cmH_2O minute / 60 seconds = 0.83 or 0.8**

b. PIP 25 cmH_20; Pplat 17 cmH_20
   I. R_{aw} = 8 cmH_20

c. Time Constant Calculation: (R_{aw} / flow L/cmH_2O second)
   I. 8 / 0.8 = 10
   II. 10 x 0.3 Time Constant = 3
      a) **Expiratory time needed** = 3 seconds

4. Given a Inspiratory flow of 60 L/cmH_2O minute, PIP 44 and Pplat 28, calculate the following based on: 3 Times Constant.

a. Inspiratory flow 60 L/cmH_2O minute
   I. **60 L/cmH_2O minute / 60 seconds = 1**
b. PIP 44 cmH_20; Pplat 28 cmH_20
   I. R_{aw} = 16 cmH_20
c. Time Constant Calculation: (R_{aw} / flow L/cmH_2O second)
   I. 16 / 1 = 16
   II. 16 x 0.3 Time Constant = 4.8
      a) **Expiratory time needed** = 4.8 seconds

5. Given a Inspiratory flow of 80 L/cmH_2O minute, PIP 44 and Pplat 15, calculate the following based on: 3 Times Constant.

a. Inspiratory flow 80 L/cmH_2O minute
   I. **80 L/cmH_2O minute / 60 seconds = 1.33 or 1.3**
b. PIP 44 cmH_20; Pplat 15 cmH_20
   I. R_{aw} = 29 cmH_20
c. Time Constant Calculation: (R_{aw} / flow L/cmH_2O second)
   I. 29 / 1.3 = 22.3 or 22
   II. 22 x 0.3 Time Constant = 6.6
      a) **Expiratory time needed** = 6.6 seconds