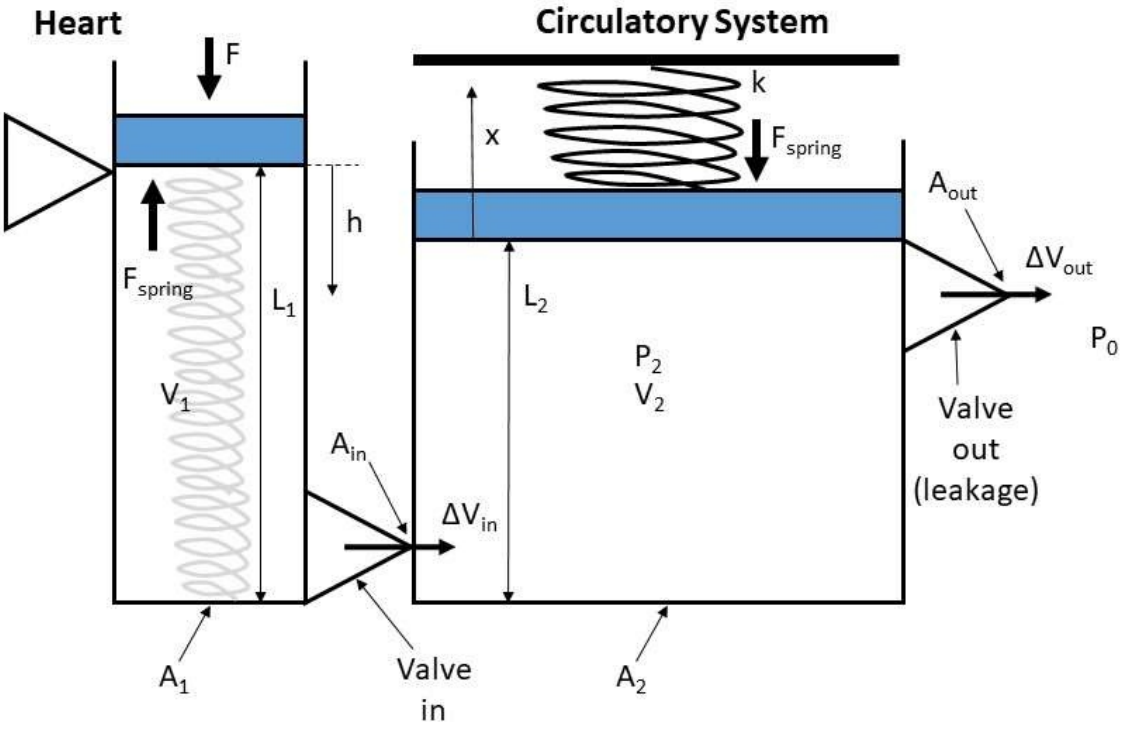
Modeling CPR With a Piston-Cylinder Apparatus



Constants: A_1 , A_2 , L_2 , k , A_{in} , A_{out} , P_0 , ρ

Volume flow into chamber 2 is equal to volume flow out of chamber 1 which is dependent only on change in h. Because of the one-way valve, as long as Δh is positive…

$$\Delta V_{in} = \Delta V_1 = A_1 * \Delta h \qquad \textbf{Eq1}$$

Now find volume flow out of chamber 2. Using Bernoulli…

$$P_2 = P_0 + \frac{1}{2}\rho v_{out}^2$$

$$P_0 = 0$$

$$v_{out} = \sqrt{\frac{2P_2}{\rho}} \qquad \textbf{Eq2}$$

$$\Delta V_{out} = v_{out} A_{out} \Delta t \qquad \textbf{Eq3}$$

Now update volume of chamber 2…

$$V_2 = V_2 + \Delta V_{in} - \Delta V_{out} \qquad \textbf{Eq4}$$

Use volume to find displacement of spring in chamber 2 (x) ...

$$V_2 = A_2(L_2 + x)$$

$$x = \frac{V_2}{A_2} - L_2 \qquad \textbf{Eq5}$$

Now use x to find spring force using Hooke's Law…

$$F_{spring} = kx \qquad \textbf{Eq6}$$

Finally, use spring force to find pressure in chamber 2…

$$F_{spring} = F_{pressure}$$

$$P = \frac{F}{A}$$

$$\boldsymbol{P_2 = \frac{F_{spring}}{A_2}} \qquad \textbf{Eq7}$$

Execute **Eq1-7** for each iteration of the loop to update volume and pressure of chamber 2. See below for Arduino script.