Quiz 1 Solution

Given:

Loaded with linear spring

Initially contains water at $P_1 = 5\,MPa$

$T_1 = 400°C$

$V_1 = 0.1\,m^3$

$P_{bottom} = 200\,kPa$

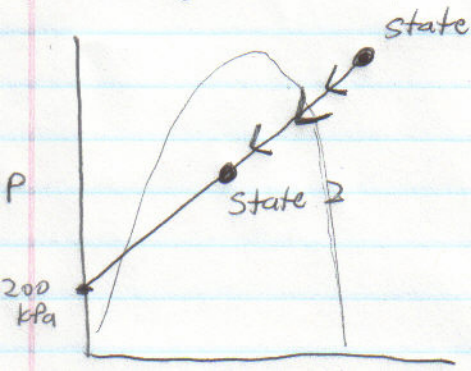
Since the arrangement is loaded with a spring Pressure varies linearly with Volume

$$P = \underbrace{C}_{\text{slope of a line}} V + \underbrace{b}_{\text{y-intercept}}$$

At $V = 0$, $P = 200\,kPa$,

$\Rightarrow P = CV + 200\,kPa$

P-V diagram



State 1

$P = 5\,MPa$, $T = 400°C$

Look up the tables for water

$v = 0.05781 \frac{m^3}{kg}$

$$m = \frac{V}{v} = \frac{0.1}{0.05781} = 1.73\,kg$$

~~P2 flow~~

$P = 200\,kPa + CV$

$$C = \frac{rise}{run} = \frac{(5000 - 200)}{0.1} = 48{,}000$$

$P = 200 + 48{,}000\,V$

Given: At state 2, $P = 1200\,kPa$

$1200 = 200 + 48{,}000\,V$

$V_2 = 0.02083$

$$v_2 = \frac{V}{m} = 0.01204 \frac{m^3}{kg}$$

Look up tables:

At $P = 1200\,kPa$, $v = 0.01204\ m^3/kg$ is between v_f and v_g

$T_2 = 188°C$

$$x = \frac{v - v_f}{v_{fg}} = \frac{0.01204 - 0.001139}{0.1622} = 0.067$$