(i)

(a) $T = 150°C$, $v = 0.35\ m^3/kg$. FIND p in bar.

SLVM because $v < v_{sat}$ (of vapor)

$\boxed{p = 4.76\ \text{bar}}$

(b) $p = 25\ MPa = 250\ \text{bar}$, $T = 100°C$. FIND v, in m^3/kg

According to the saturation table @ $T = 100°C$ $p_{sat} = 1.01$ bar and because $p > p_{sat}$ $\therefore$ so it is CL instead

thus

$\boxed{v = 1.03 \times 10^{-3}\ m^3/kg}$

(c) $p = 20\ MPa$, $T = 485°C$. FIND v, in m^3/kg

According to saturation table we have $p_1 = 186.66$ bar and $p_2 = 218.51$ bar, which are 360°C and 373.1°C respectively. Since these two temp.s are both smaller than 485°C, we take a look at ($T_{sat} < T$) SHV thus, we have

$$T_1 = 440°C \ \&\ T_2 = 500°C$$
$$v_1 = 0.16109\ m^3/kg \ \&\ v_2 = 0.17568\ m^3/kg$$

we interpolate

$$v = [(485 - 440)°C] \frac{(0.17568 - 0.16109)\ m^3/kg}{(500 - 440)\ °C} + 0.16109\ \frac{m^3}{kg}$$

$$v \cong 0.172033$$

$\boxed{v = 0.172\ m^3/kg}$

(d) $T = 80°C$, $x = 0.75$. FIND p, in bar & v in m^3/kg

According to saturation table @ $T = 80°C$

because $H_2O(l)$ & $H_2O(g)$ coexist - SLVM

$\boxed{p = 0.474\ \text{bar}}$

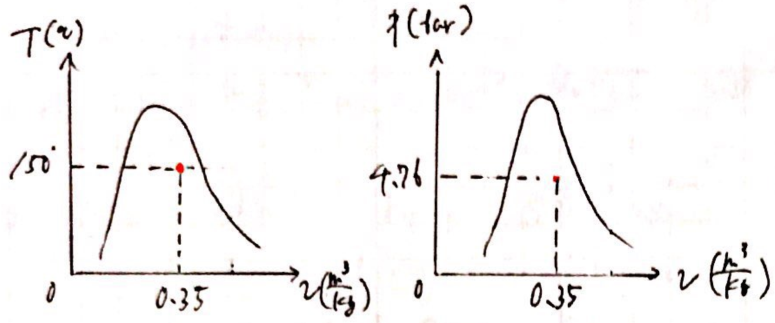
and $v_f = 1.0291 \times 10^{-3}\ m^3/kg$, $v_g = 3.4052\ m^3/kg$

thus

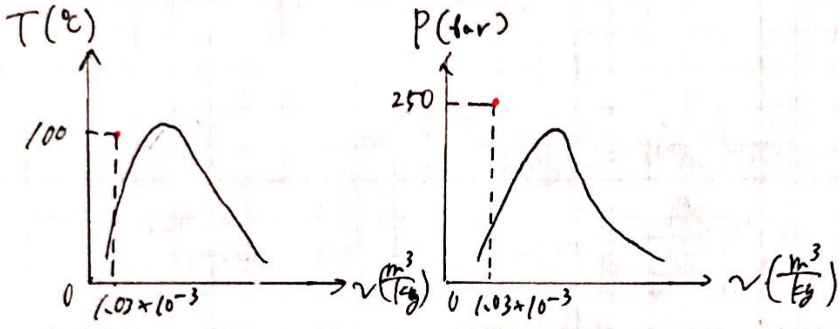
$$v = (1-x)v_f + xv_g = 0.25 \times 1.0291 \times 10^{-3}\ \frac{m^3}{kg} + 0.75 \times 3.4052\ \frac{m^3}{kg}$$
$$\cong 2.55416$$

$\boxed{v = 2.55\ \frac{m^3}{kg}}$

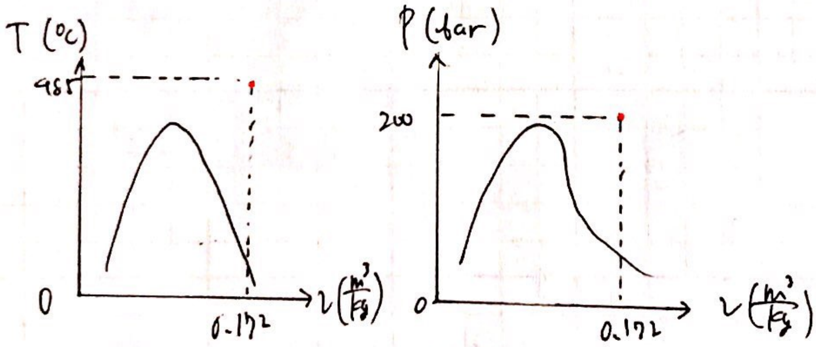
(a)

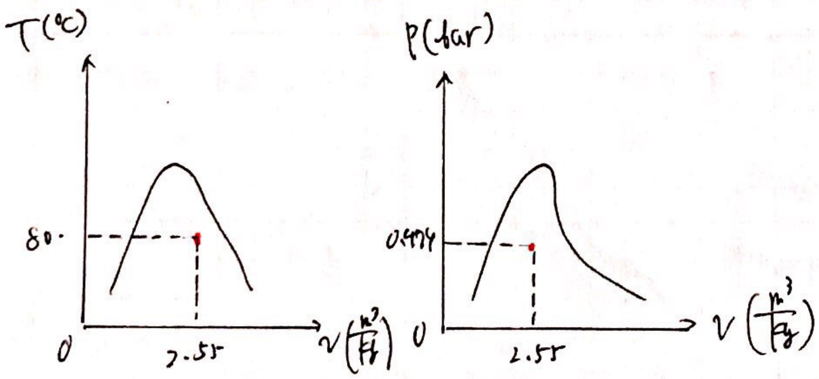

T(°C)
150
0
0.35
v(m³/kg)
p(bar)
4.76
0
0.35
v(m³/kg)

(b)


T(°C)
100
0
1.03×10⁻³
v(m³/kg)
P(bar)
250
0
1.03×10⁻³
v(m³/kg)

(c)


T (°C)
985
0
0.172
v(m³/kg)
P(bar)
200
0
0.172
v(m³/kg)


T(°C)
80
0
2.55
v(m³/kg)
P(bar)
0.4474
0
2.55
v(m³/kg)

(ii)

GIVEN

closed, rigid cylinder

>> diff. vol.s of "saturated" $H_2O(l)$ and $H_2O(g)$

>> $T = 150°C$

>> heights *cylinder, $h_{cyn} = 50.$ (assume cm)

*saturated liquid = 20 cm

*saturated vapor = 30 cm (20 ~ 50)

FIND

quality of mixture, x, in %

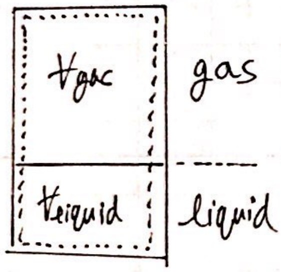
ASSUMP

- closed sys.
- saturated states
- able to use SLTM
- Area is arbitrary

EQN

- $\frac{dm}{dt}\Big|_{sys} = \dot{m}_{in} - \dot{m}_{out} = 0$
- $x = \frac{m_{vapor}}{m_{liquid} + m_{vapor}}$
- $V = Ah$ (Area × height)

FBD



SOLN

from SLTM @ $T = 150°C$

$v_f = 0.0010905 \ m^3/kg$, $v_g = 0.39245 \ m^3/kg$

if cross-sectional Area of cylinder is $A \ m^2$

$V_{gas} = A \times (0.300 \ m) = 0.300A \ m^3$

$V_{liquid} = A \times (0.200 m) = 0.200A \ m^3$

since $m_{vapor} = \frac{V_{gas}}{v_g} = \frac{0.300A}{0.39245} kg$

$m_{liquid} = \frac{V_{liquid}}{v_f} = \frac{0.200A}{0.0010905} kg$

$$x = \frac{\frac{0.300A}{0.39245} kg \times 100}{\left(\frac{0.200A}{0.0010905} + \frac{0.300A}{0.39245}\right) kg} \approx \frac{0.7644 \times 100}{0.7644 + 183.4021} \approx 0.4151\%$$

$\boxed{x = 0.415 \ \%}$