DO NOT WRITE ON THE BLUE TABLES. RETURN THE BLUE TABLES WITH YOUR EXAM. DO NOT STAPLE THE EXAM SHEETS TOGETHER. Put your answers on the same sheet as the question, Use many digits in your computation. You must give the units of your answers. You must write clearly. Encircle the right answer number in multiple choice. To correct, erase the wrong circle as well as you can and encircle the corrected answer number twice. Best possible answer for multiple choice. For questions asking a number, putting the clear correct formula(s) below the question might result in partial credit even if the answer is wrong. *Not following those requirements will result in reduced or no credit.*

1. (5%) The absolute pressure inside a vessel is 97 kPa. A manometer filled with mercury measuring this pressure and at the other side open to a 100 kPa ambient pressure will show a deflection 22.519 mm

2. (5%) A cylinder with a heavy piston on top and an area of 0.1 m^2 contains saturated water at 200kPa. The ambient pressure is 100 kPa. The mass of the piston is 1019 kg.

3. (5%) Which of the below information would be sufficient to figure out the density of water:
   - ((a)) P and T
   - (b) P and V.
   - (c) T and V

4. (5%) Which of the systems below is described as a control volume and not a control mass:
   - (a) Air in a spinning tire.
   - ((b)) A running faucet.
   - (c) Water in a piston-cylinder configuration.

5. (5%) Saturated liquid is contained within a rigid container. If the temperature is raised just a little bit, it turns into:
   - ((a)) compressed liquid.
   - (b) liquid-vapor mixture.
   - (c) vapor.

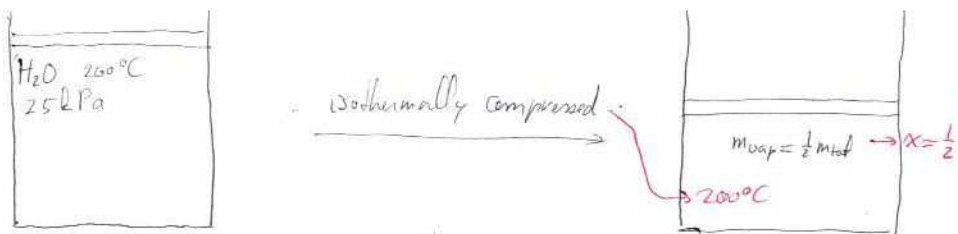
6. (5%) If water at 300°C has a volume of 0.01 m^3/kg, then the quality is 42.4 %.

7. (5%) The specific volume of water at 5000 kPa and 100°C is 0.001041 m^3/kg. If you did not have the right table, the value you would use instead would be 0.001044 m^3/kg. Give all possible digits for each.

8. (33%) A piston-cylinder combination contains water at 200°C and 25 kPa. The water is then isothermally compressed until half the mass is vapor.

   - In a very neat Pv diagram, construct the initial phase of the water. Do not include any more information than is needed to construct the phase, but do list the value of all lines that are used to do it. State what the initial phase is.
   - Give the initial specific volume.
   - In a second very neat Pv diagram, show the process from the initial state to the final state as a fat line. Mark the intial state as 1 and the final one as 2.
   - What are the final pressure and specific volume, to five digits?

   You must show the derivations and reasoning completely and correctly for full credit. You must give units for your answers. Most accurate procedure only unless stated otherwise.



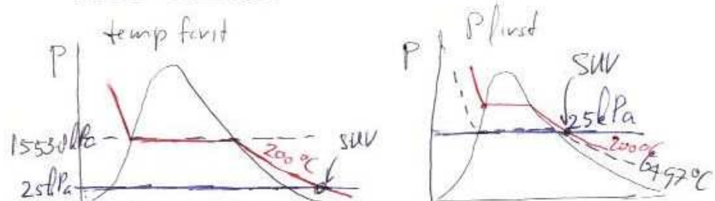
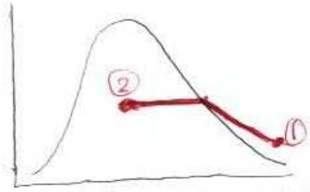


Table B.1.3 @ 200°C P = 25 kPa = g $g_1 = 10$ kPa $d_1 = 21.82507$ m³/kg
$g_2 = 50$ kPa $d_2 = 4.35595$ m³/kg

$$v = d = 21.82507 \frac{m^3}{kg} + \frac{25-10}{50-10}(4.35595 - 21.82507)\frac{m^3}{kg}$$
$$= \underline{15.27415} \ m^3/kg$$



$P_2 = \underline{1553.8 \text{ kPa}}$

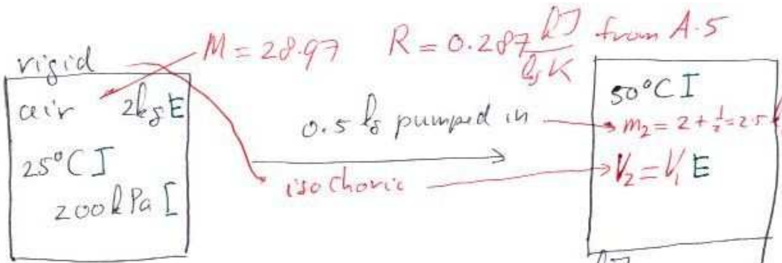
$v_2 = v_{f_2} + x\, v_{fg_2} = 0.001156 + 0.5 \cdot 0.12620$
$= \underline{0.064256 \ m^3/kg}$

(1) diagram (2) read CL table (3) comps & units
(2) line 1 (5) interpolate
(2) sat vap (2) show process (2) $T_2 = 200°C$ v_f v_{fg}
(1) plot (2) (3) give sat P
(2) line 2 (4) formula
(1) phase (3) $x_2 = \frac{1}{2}$

9. (32%) A rigid container holds 2 kg of air at 25°C and 200 kPa. Then an additional 0.5 kg of air is pumped in. The temperature becomes 50 °C.

- What is the initial volume and number of moles?
- What is the final pressure in atmospheres to 4 digits?

You must show the derivations and reasoning completely and correctly for full credit. You must give units for your answers. Most accurate procedure only unless stated otherwise.



$P_1 V_1 = m_1 R T_1$ $\quad 200\ \text{kPa}\ V_1 = 2\ \text{kg}\ 0.287 \frac{\text{kJ}}{\text{kg K}} (25 + 273.15)\ \text{K}$

$V_1 = 0.8557 \frac{\text{kJ}}{\text{kPa}} = \underline{\underline{0.8557\ \text{m}^3}}$

$n = \frac{m}{M} = \frac{2\ \text{kg}}{28.97\ \text{kg/kmol}} = 0.069037\ \text{kmol} = \underline{\underline{69.037\ \text{mol}}}$

$P_2 V_2 = m_2 R T_2$ $\quad P_2\ 0.8557\ \text{m}^3 = 2.5\ \text{kg}\ 0.287 \frac{\text{kJ}}{\text{kg K}} (50 + 273.15)\ \text{K}$

$P_2 = 270.962\ \text{kPa} \times \frac{1\ \text{atm}}{101.325\ \text{kPa}} = \underline{\underline{2.6742\ \text{atm}}}$

(5) $PV = mRT$ or equiv (4) $m_2 = m_1 + 0.5$
(3) R, M from A 5 (4) $V_2 = V_1$
(3) T → K (2) compute P_2 (units!)
(3) compute V_1 (units!) (2) kPa → atm
(3) $n_1 = \frac{m}{M}$ or equiv → substituted for eqns using $pV = n\bar{R}T$
(3) convert to moles
→ kmol listed: 2