EML 3100 Exam 1 **THERMODYNAMICS** **1/30/07 11:45-1:00 pm**
Page 1/3 Solutions (dommelen@eng.fsu.edu) series a

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%) A water-filled manometer has an atmospheric pressure of 101 kPa at one end and an absolute pressure of 105kPa at the other side. The manometer will read 40.77 cm

2. (5%) If we put a 10 kg weight on a frictionless piston-cylinder device whose piston has a mass of 1 kg and a diameter of 10 cm, and the atmospheric pressure is 100 kPa, the absolute pressure of the substance inside will be 113.74 kPa.

3. (5%) What information would be sufficient to find the temperature of a substance for which you have tables:
   [✓ (a)] quality and pressure
   (b) quality and volume
   (c) pressure and volume

4. (5%) 5 moles of ethyl alcohol weigh 2.260 N

5. (5%) A weighted piston-cylinder device contains saturated liquid. If we add a bit of heat,
   (a) the pressure will go up
   (b) the temperature will go up
   [✓ (c)] the volume will go up

6. (5%) We have water at 90°C in a vacuum chamber which is at the ambient pressure of 100 kPa. How much do we need to lower the pressure in the chamber to get the water to boil at 90°C? 29.817 kPa

7. (5%) The quality of a substance with a specific volume of 0.7 m^3/kg is 66.67 % if the specific volume of saturated liquid at the same temperature is 0.1 m^3/kg and that of saturated vapor 1 m^3/kg.

8. (33%) Two kilograms of water at 25°C and at a specific volume of 0.0017 m^3/kg fill a rigid container.

   (a) Give the volume of the container.

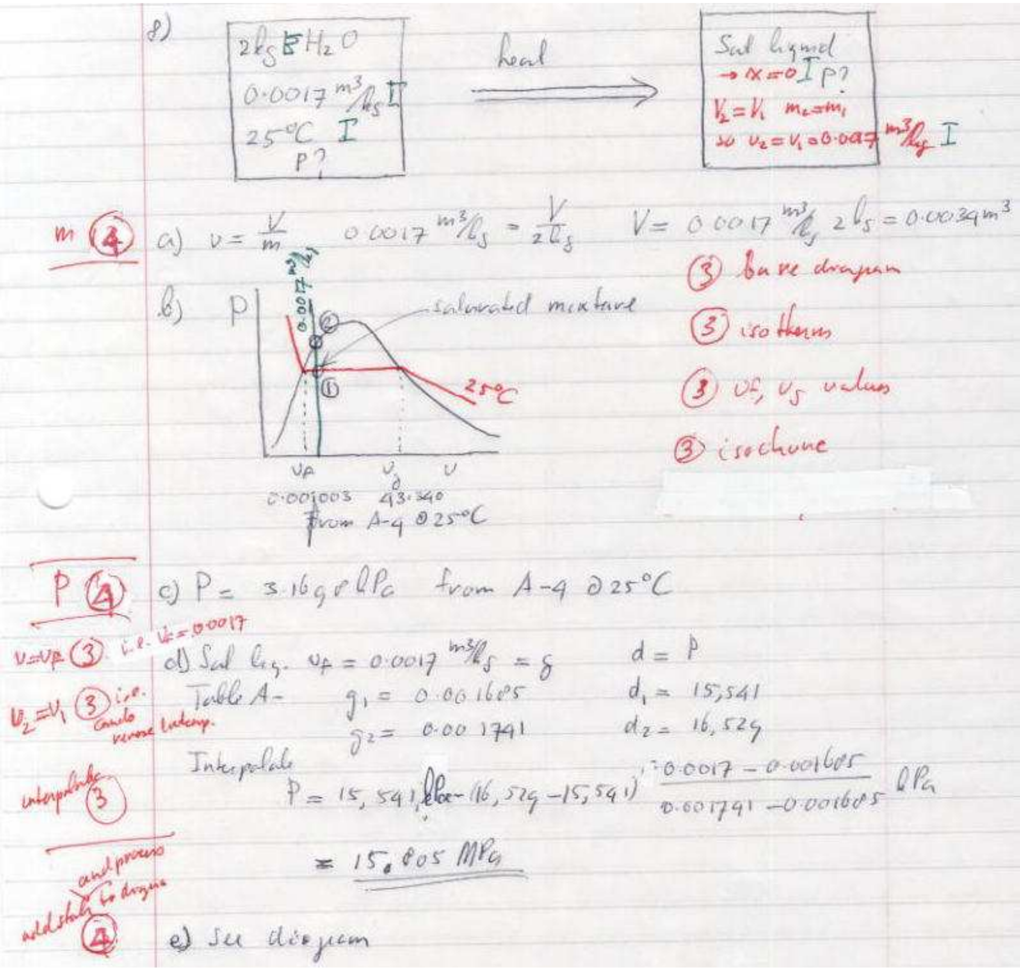
   (b) Construct the phase of the water in a very neat Pv-diagram, marking all lines and points used to do it with their values.

   (c) Give the pressure.

   (d) If the rigid container is now heated until the water turns into saturated liquid, what is the pressure then?

   (e) Show the process also in your Pv-diagram, marking the final state as "2".

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.



8)

2kg ~~E~~ H_2O
0.0017 m^3/kg I
25°C I
P?

heat ⟹

Sat liquid
→ x = 0 I P?
$V_2 = V_1$ $m_2 = m_1$
so $v_2 = v_1 = 0.0017$ m^3/kg I

m ④ a) $v = \frac{V}{m}$ 0.0017 m^3/kg $= \frac{V}{2\,kg}$ $V = 0.0017\ \frac{m^3}{kg}\ 2\,kg = 0.0034\,m^3$

b)

③ basic diagram
③ isotherms
③ v_f, v_g values
③ isochore

P ④ c) P = 3.169 kPa from A-4 @ 25°C

$v = v_f$ ③ i.e. $v_f = 0.0017$

$v_2 = v_1$ ③ i.e. Cengel reverse interp.

d) Sat liq. $v_f = 0.0017$ m^3/kg = g   d = P
Table A- $g_1 = 0.001605$ $d_1 = 15{,}541$
$g_2 = 0.001741$ $d_2 = 16{,}529$

interpolate ③

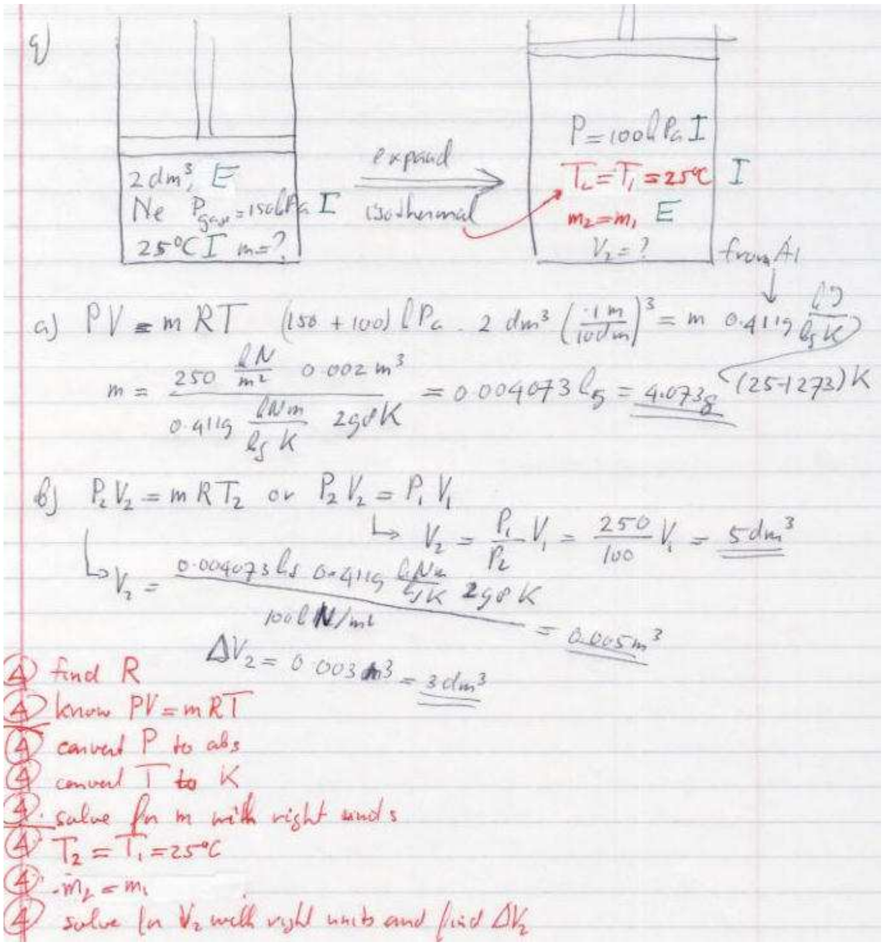
Interpolate
$P = 15{,}541 + (16{,}529 - 15{,}541)\ \frac{0.0017 - 0.001605}{0.001741 - 0.001605}$ kPa

$= \underline{15.805\ MPa}$

add state and process to diagram ④ e) See diagram

9. (32%) Two dm^3 of neon in a piston cylinder setup has a gage pressure of 150 kPa and a temperature of 25°C. It is to be expanded to the ambient pressure of 100 kPa.
   (a) What is the mass of the neon?
   (b) How much must we increase the volume to reduce the pressure to the ambient one if the expansion is isothermal?

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.



a) $PV = mRT$ $(150 + 100)\,\text{kPa} \cdot 2\,\text{dm}^3 \left(\frac{.1\,\text{m}}{1\,\text{dm}}\right)^3 = m\, 0.4119 \frac{\text{kJ}}{\text{kg K}} (25+273)\,\text{K}$

$$m = \frac{250 \frac{\text{kN}}{\text{m}^2}\ 0.002\,\text{m}^3}{0.4119 \frac{\text{kNm}}{\text{kg K}}\ 298\,\text{K}} = 0.004073\,\text{kg} = \underline{\underline{4.073\,\text{g}}}$$

b) $P_2V_2 = mRT_2$ or $P_2V_2 = P_1V_1$

$\hookrightarrow V_2 = \frac{P_1}{P_2}V_1 = \frac{250}{100}V_1 = \underline{\underline{5\,\text{dm}^3}}$

$$\hookrightarrow V_2 = \frac{0.004073\,\text{kg}\ 0.4119 \frac{\text{kNm}}{\text{kg K}}\ 298\,\text{K}}{100\,\text{kN/m}^2} = \underline{\underline{0.005\,\text{m}^3}}$$

$\Delta V_2 = 0.003\,\text{m}^3 = \underline{\underline{3\,\text{dm}^3}}$

④ find R
④ know $PV = mRT$
④ convert P to abs
④ convert T to K
④ solve for m with right units
④ $T_2 = T_1 = 25°C$
④ $m_2 = m_1$
④ solve for V_2 with right units and find ΔV_2