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 at least 5 significant digits in your computations and answers where possible. 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%) If you compute the enthalpy change of oxygen between 300 and 1200 K using the room temperature specific heat, the answer would be in error by ___98.58___ kJ/kg.

2. (5%) For an ideal gas, with what the book calls a molecular mass of 50, only internal energy tables are available. If the internal energy changes by 2000 kJ/kg between 300 and 1200 K, then the enthalpy changes by ___2149.7___ kJ/kg.

3. (5%) To heat 0.2 L of aluminum at 3°C/s requires ___1.458___ kW of heat.

4. (5%) For an ideal gas, with what the book calls a molecular mass of 50, what can you say about heat and work in an isothermal process? ___They will be equal___.

5. (5%) If 0.5 kg of brass at 500°C is dropped into 2 kg of light oil at 20°C, then ignoring heat conduction with the surroundings, the final temperature of brass and oil will be ___44.063___ °C.

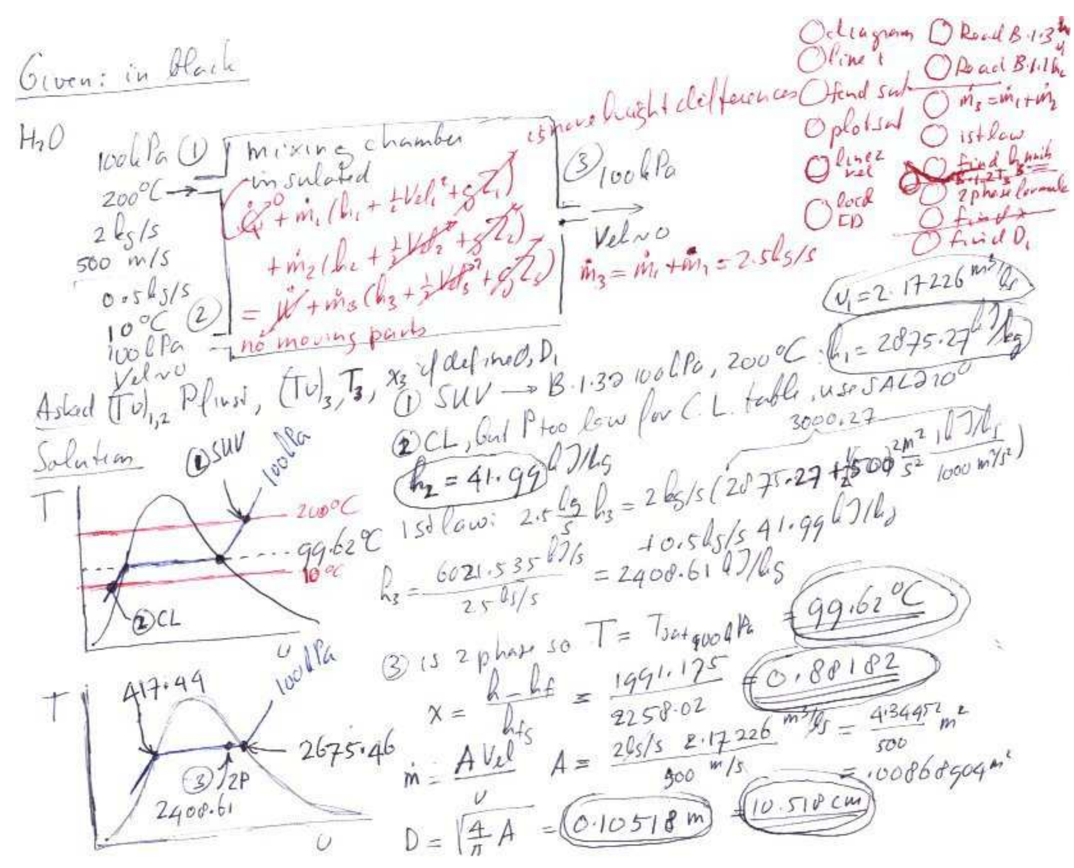
6. (5%) If you compute the enthalpy change of oxygen between 300 and 1200 K using the specific heat at the average temperature, the answer would be in error by ___11.63___ kJ/kg.

7. (5%) Atmospheric air at 85 kPa and 25°C is rising upwards while expanding at a rate of 0.05 m^3/kg s. The process can safely be assumed to be adiabatic. The temperature of the air is increasing at a rate of ___-5.9275___ °C/s.

8. (33%) A 2 kg/s stream of water at 100 kPa and 200°C enters an insulated mixing chamber with a speed of 500 m/s. A second 0.5 kg/s stream of water at 100 kPa and 10°C enters the mixing chamber at negligible velocity. The pressure drop across the mixing chamber can be ignored and the exit velocity is negligible..

   - Construct the phases of the entering streams in a single very neat Tv-diagram, doing pressure first, and marking all lines and points used to do it with their values. Do not put more info in the diagram than is needed to construct the phases. State the phases.
   - Construct the phase of the exiting stream in a second Tv-diagram, otherwise meeting the same criteria as the first.
   - Find the exit temperature and quality, if any.
   - What is the diameter of the pipe through which the first stream enters, in cm?

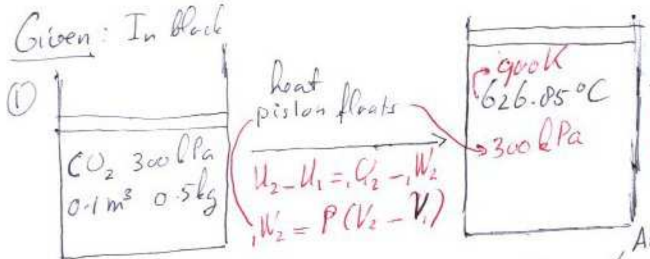
   You must show the derivations and reasoning completely and correctly for full credit. You must give simplified units for your answers. Most accurate procedure only unless stated otherwise. Use at least 5 significant digits in your computations and answers. *Give the source of every number.*



9. (32%) Carbon dioxide is confined inside a cylinder by a piston that floats on it. Initially there is 0.5 kg of carbon dioxide at 300 kPa and 0.1 m^3. Then the carbon dioxide is heated to 626.85°C. Find the increase in gravitational potential energy of the piston, and the amount of heat added.

   You must show the derivations and reasoning completely and correctly for full credit. You must give simplified units for your answers. Most accurate procedure only unless stated otherwise. Use at least 5 significant digits in your computations and answers. *Give the source of every number.*

Given: In black



○ $PV = mRT$
○ R
○ Find (V_2) T_1 units
○ Read A5
○ Interpolate u_1
○ ${}_1W_2$ form
○ find ${}_1W_2$ unit
○ 1st law
○ find ${}_1Q_2$, units

Asked: ${}_1W_2$, ${}_1Q_2$

Solution $P_2V_2 = mRT_2$ 300 kPa $V_2 = 0.5$ kg 0.1889 $\frac{kJ}{kg\,K}$ (626.85 + 273.15) K [= 900 K; 0.1889 from A5]

$P_1V_1 = mRT_1$ 300 kPa 0.1 m^3 = 0.5 kg 0.1889 $\frac{kJ}{kg\,K}$ T_1

($V_2 = 0.28355$)

($T_1 = 317.63$ K)

${}_1W_2 = P(V_2 - V_1) = mR(T_2 - T_1) =$ (55.005 kJ) (kPa m^3) $= \Delta E_{pg} = m_p g \Delta z$

$d = u_1$ $g = 317.63$ K $g_1 = 300$ K $g_2 = 350$ K

$d_1 = 157.7 \frac{kJ}{kg}$ $d_2 = 191.78 \frac{kJ}{kg}$ ($u_1 = 169.716 \frac{kJ}{kg}$)

($u_2 = 676.69$) ${}_1Q_2 = U_2 - U_1 + {}_1W_2 = 0.5$ kg (676.69 − 169.716) $\frac{kJ}{kg}$ = (308.49 kJ)

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