DO NOT WRITE ON THE BLUE TABLES. RETURN THE BLUE TABLES WITH YOUR EXAM. DO NOT STAPLE THE EXAM SHEETS TOGETHER. A letter-size formulae sheet, handwritten by you, may be used. 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 internal energy change of oxygen between 300 and 700 K using table A.5 only, you get 264.8 kJ/kg, which is in error by 20.18 kJ/kg.

2. (5%) If 2 kg of steam at 1400 kPa and 200°C must enter a turbine at no more than 60 m/s, the minimum required input pipe cross sectional area is 0.0047673 m^2 and the diameter is 7.791 cm.

3. (5%) The specific heat at constant volume of oxygen at 700 K is 0.77154 kJ/kg-K.

4. (5%) Half a kg of oxygen is currently at 200 kPa and 25°C. The volume is decreasing at a rate of 7 L/s and 0.05 kW of heat leaks *out* the oxygen. The temperature of the oxygen is increasing at a rate of 4.0785 °C/s.

5. (5%) If you dump 3 kg of brick at 50°C and 1 kg of ammonia at 20°C in an insulated container, the mix will stabilize at a final temperature of 30.895 °C.

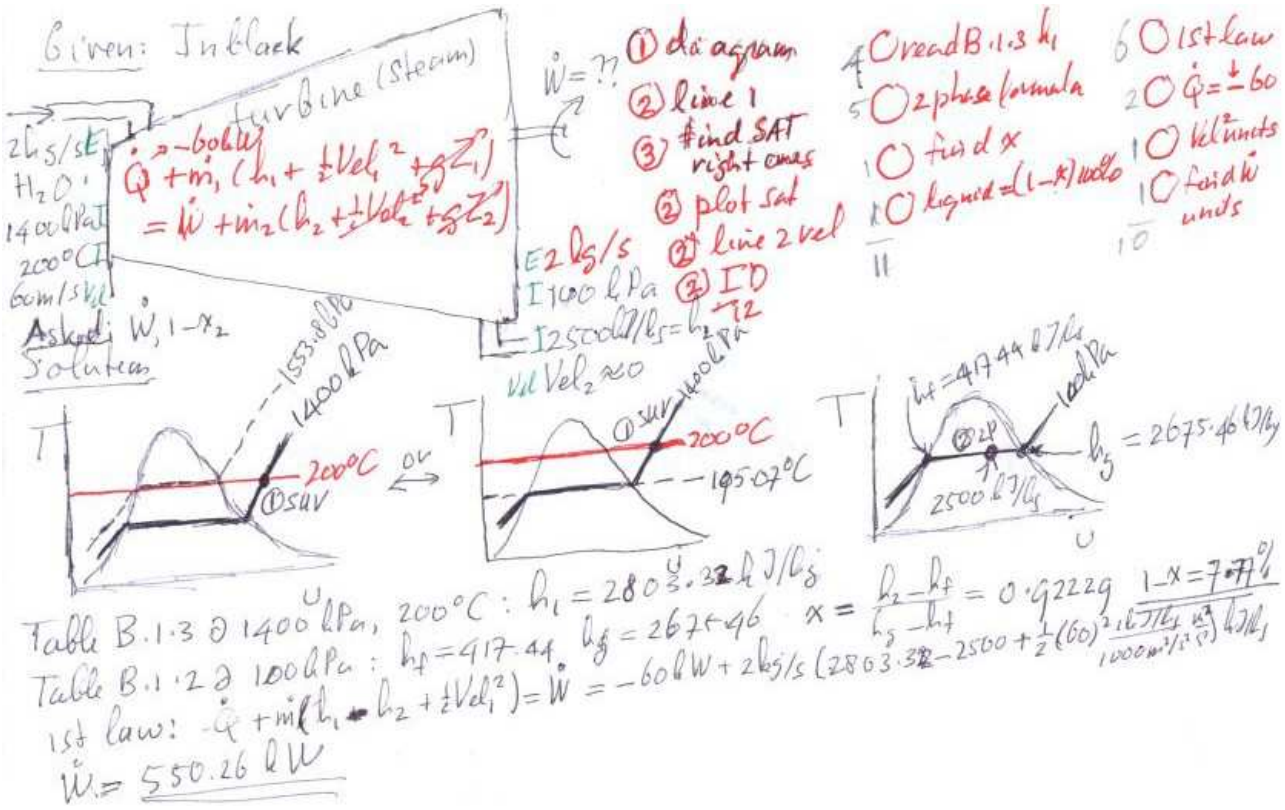
6. (5%) For an ideal gas with given complete tables, how many of the following quantities can you find if you know temperature and mass only? $C_p, C_v, h, H, P, PV, rho, T, T/v, u, U, v, V$? 10

7. (5%) To heat 3 kg of asphalt at a rate of 0.5°C/s requires 5.52 kW of heat.

8. (33%) A 2 kg/s stream of water at 1400 kPa and 200°C enters a steam turbine with a speed of 60 m/s. The water exits the turbine at 100 kPa with a specific enthalpy of 2,500 kJ/kg and negligible velocity. It is observed that 60 kW of heat leaks out of the hot turbine.

   - Construct the phase of the entering stream in a very neat Tv-diagram, 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 phase. State the phase of the marked constructed point.
   - Construct the phase of the exiting stream in a second Tv-diagram, otherwise meeting the same criteria as the first.
   - What percentage of the mass of the exiting steam is liquid?
   - What is the power provided by the turbine?

   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%) An isobaric container with an initial volume of 6 m^3 contains 3 kg of hot oxygen at the ambient pressure of 90 kPa. Then the oxygen cools down to the ambient temperature of 26.85°C. Find the work done by the oxygen and the heat that it releases into the surroundings.

   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.*