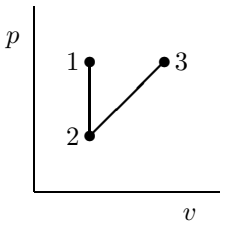
DO NOT WRITE ON THE BLUE TABLES.
RETURN THE BLUE TABLES WITH YOUR EXAM.
DO NOT STAPLE THE 3 EXAM SHEETS TOGETHER.

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. *Not following those requirements will result in reduced or no credit.*

1. (5%) An amount of substance undergoes a three-step process as shown in the figure.



The correct expression for the work performed by the substance in the process is, in terms of the intensive and extensive values of the states 1, 2, and 3 (use subscripts) is: $\frac{1}{2}(p_2 + p_3)(V_3 - V_2)$

2. (5%) Heat is added to 2 kg propane at 200 kPa and room temperature at a rate of 3 kJ/s. The rate of temperature change is 0.893 °C/s

3. (5%) 2 kg of Helium is compressed from ambient conditions, 100 kPa and 15°C, to 300 kPa. If the Helium heats up to 35°C during the compression, its specific internal energy changes by 62.32 kJ/kg

4. (5%) The specific heat at constant pressure of nitrogen at 800°C is 1.1813 kJ/kg-K

5. (5%) To raise the temperature of 5 L of glycerine from 20 to 100°C requires 1219.68 kJ of heat

6. (5%) If 2 kg of a substance at 200 kPa in a 4 m^3 container has a specific internal energy of 150 kJ/kg, then its specific enthalpy is 550 kJ/kg

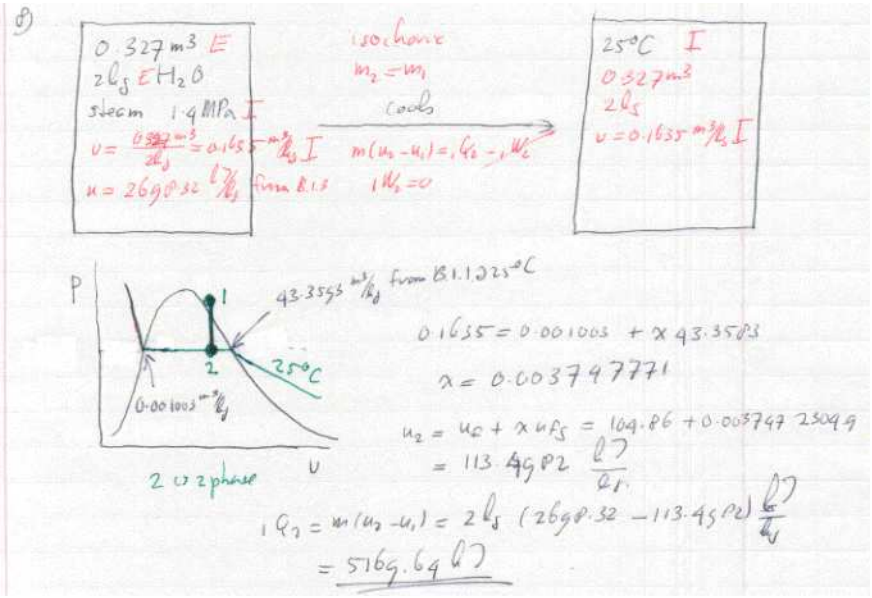
7. (5%) A piston cylinder combination contains 2 m^3 of air at 100 kPa. To compress the air isothermally to 200 kPa, the work the piston must do on the air equals 138.63 kJ

8. (33%) A rigid chamber with a volume of 0.327 m^3 contains 2 kg of water as steam at 1.4 MPa. This water now cools to room temperature, which is 25 °C. Construct and name the final phase in the *pv* diagram, and show the process in it, and find the heat lost to the room.

   You must construct all phases that are not given in the *pv*-diagram, marking all lines used to do it with their values. Unambiguously number the phases in the diagram.

   Also show the process as a fat curve in the diagram.

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



9. (32%) A high-velocity stream of nitrogen at 200 kPa and 150°C enters a mixing chamber through a pipe with a diameter of 10 cm at a rate of 2 kg/s. A second low velocity stream of nitrogen at 100 kPa and 27 °C enters through another pipe at a rate of 3 kg/s. The two streams mix in the mixing chamber and exit the chamber together at 100 kPa and negligible velocity. The chamber loses 50 kW of heat to the surroundings. What is the temperature of the exiting nitrogen?

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