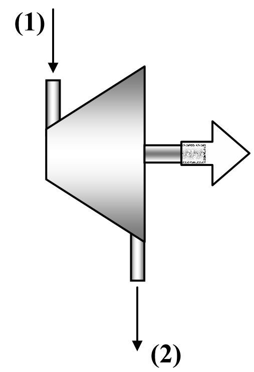
Mayhew/Sanders Exam 2

Problem 1 (40 points) DO NOT INTERPOLATE – USE CLOSEST TABULATED VALUE

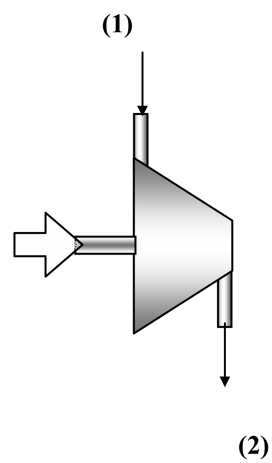
An adiabatic steam turbine operates at steady-state. The steam enters the turbine at 3.5 MPa and 450°C and exits at 0.1 MPa. The mass flow rate through the turbine is 25 kg/s. The isentropic efficiency of the turbine is 0.71.



FIND:
(a) Power output of the turbine in kW.
(b) Exit temperature and phase

Problem 2 (40 points) DO NOT INTERPOLATE – USE CLOSEST TABULATED VALUE

An adiabatic compressor draws 5 kg/s of air (ideal gas) at 1 atm pressure (101 kPa), 27 °C, and delivers air at 5 atm and 247 °C. Find:
(a) (15 points) the required power input, in kW,
(b) (15 points) the compressor efficiency, and
(c) (10 points) the rate of entropy production, in kJ/K-sec.



Problem 3 (20 points) DO NOT INTERPOLATE – USE CLOSEST TABULATED VALUE

a) (5 points) Find the specific entropy (kJ/kg-K) of R-134a at 0.9 MPa and 12 °C.

b) (5 points) Find the specific volume (m^3/kg) of R-134a at 0.9 MPa and x=0.5

c) (10 points) Find the exit temperature of an adiabatic, reversible R-134a compressor with saturated vapor at 0.18 MPa at the inlet and an exit pressure of 0.5 MPa.

Lui/Richards Exam 2

Problem 1 (32 points)

Complete the information in the table for refrigerant 134a (**R-134a).** Entries that require calculations are worth 4 points. Entries that only require a simple look up are worth 2 points.

For **phase**, indicate whether it is a compressed liquid (**CL**), saturated liquid (**SL**), saturated mixture (**SM**), saturated vapor (**SV**), or superheated vapor (**SHV**).

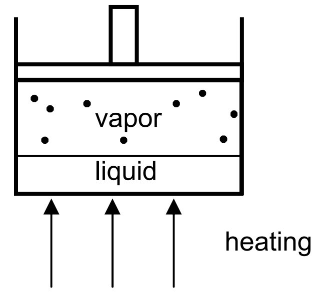
For **properties** and **quality**, provide a number or indicate it is not applicable (N/A).

State	**Phase**	***T*** °C	***P*** MPa	***x***	***υ*** m³/kg	***h*** kJ/kg	***s*** kJ/(kg·K)
1		60				172.71	
2		60					0.9527
3		60	0.8				
4		60	3.0				
5	*SV*		3.0				

For answers that require calculations, show your work below as you feel necessary. ***Full credit* will be given if we only have to punch *your* numbers into a calculator.**

Problem 2 (34 points)

A saturated mixture of water with an initial quality of 50%, a pressure of 100 kPa, and mass of 2 kilograms is contained in a piston cylinder device. During a constant pressure process, the water is heated to a temperature of 200°C.



(a) Sketch the process on a *P*-*v* and a *T*-*v* diagram. Clearly label the initial state, final state, and the process line.

(b) Determine the *magnitude* and *direction* of the *work* and *heat transfer* for the process, in kJ.

Additional discussion: If the constant pressure process is replaced by a constant temperature process, how will the analysis be different?

Problem 3 (34 points)

One way to provide air for cooling the passengers on an airliner is to expand high pressure air through an adiabatic, steady-state turbine as shown in the figure.

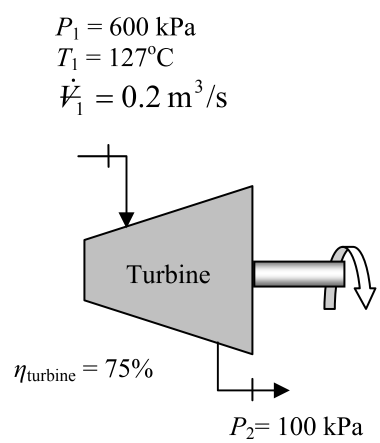
The inlet and outlet information is shown on the figure. The inlet volumetric flow rate is 0.2 m^3/s, and the turbine has an isentropic efficiency of 75%.

Assume air can be modeled as an ideal gas and use the *ideal gas tables*. **Do not interpolate—use closest values.**

(a) Sketch the process on a *T*-*s* diagram.

(b) Determine the power output from the turbine, in kW.

(c) Determine the outlet air temperature.



Hydrostatics

Determine the *minimum* vertical force, ***F***, required to hold the gate closed if its width (into the page) is *w*. Neglect the weight of the gate and assume the hinge is frictionless.