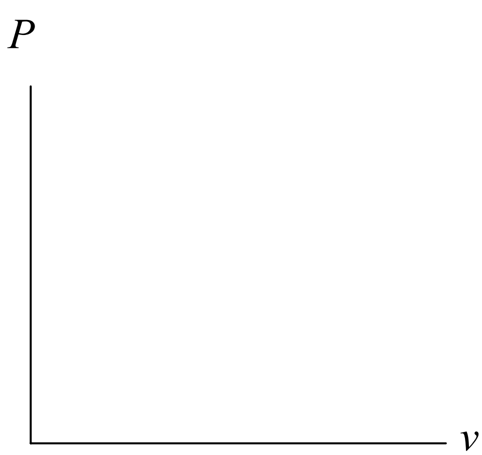
1) Provide the information requested in the table for WATER. When specifying the phases use the following abbreviations:

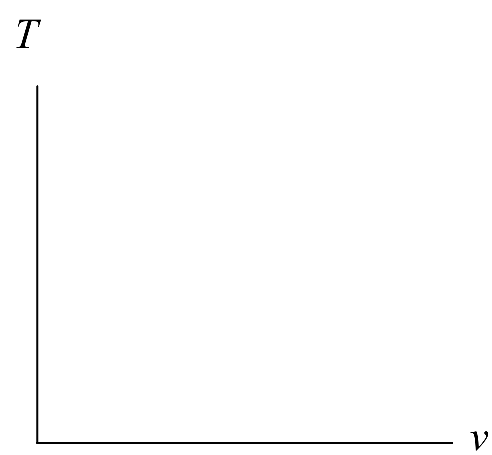
CL = compressed (subcooled) liquid
SL = saturated liquid
SM = saturated mixture
SV = saturated vapor
SHV = superheated vapor

Use "NA" for items that are not applicable at a particular state.
Use "ND" for items that cannot be fully specified.

State	Phase	Pressure, *P* [kPa]	Temper-ature *T* [°C]	Quality, *x*	Specific Volume, *v* [m^3/kg]	Specific Internal Energy, *u* [kJ/kg]	Specific Enthalpy, *h* [kJ/kg]	Specific Entropy, *s* [kJ/(kg-K]
1		2000	200					
2		1000	200					
3		1553.8	200					
4			200		0.100			
5		100				2658.1		
6		100				800		
7		100	20					

Plot the states on the *P*-*v* and *T*-*v* diagrams below. Positions may be approximate but relative positions should be correct when compared with other states and saturation curves.





2) Calculate the change in
   a. internal energy

   b. enthalpy

   c. entropy

   for 2 kg of air from an initial temperature of 20 deg C and an initial pressure of 100 kPa to
   - 200 deg C and 350 kPa

   - 2000 deg C and 700 kPa

   Perform your calculation by using
   i. property table

   ii. "average" specific heats

3) For the same initial state as previous problem, if the process is isentropic, what will the final temperature be if the final pressures are the same as those in the previous problem?

4) An adiabatic compressor compresses air from room conditions (20 deg C and 100 kPa) to 300 deg C and 550 kPa. Determine its isentropic efficiency. Reason out your calculation using
   a. basic definition

   b. appropriate approximation

and examine the simplification introduced by your approximation.

5) Consider a steam power plant that operates on a simple ideal Rankine cycle and has a net power output of 30 MW. Steam enters the turbine at 7 MPa and 500 deg C and leaves the turbine at 10 kPa. It then enters a condenser at 10 kPa and is cooled by running cooling water from a lake through the tubes of the condenser at a rate of 2000 kg/s.

   a. Show the cycle on a *T-s* diagram with respect to the saturation lines.

   b. Determine the work and heat transfer per unit mass flow for each process of the cycle.

   c. Determine the thermal efficiency of the cycle.

   d. Determine the temperature rise of the cooling water as it flows through the condenser.

   e. Repeat all of the above if the isentropic efficiency of the pump and turbine are 80% and 75% respectively.

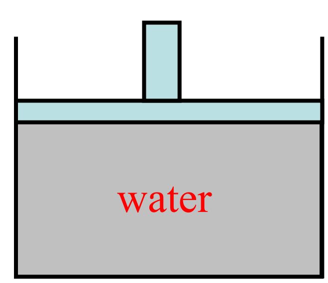
6) Water contained in a piston-cyliner assembly undergoes two processes in series from an initial state where the pressure is 10 bar and the temperature is 400 deg C.

<u>Process 1</u>: The water is cooled as it is compressed at a constant pressure of 10 bar to the saturated vapor state.

<u>Process 2:</u> The water is further cooled at constant volume to 150 deg C.

a. Determine the overall work for the overall process.

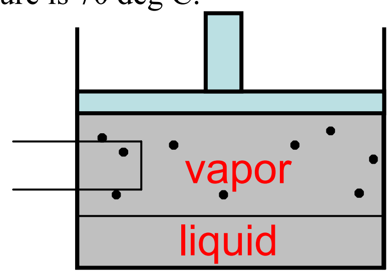
b. Determine the overall heat transfer for the overall process.



c. Sketch the whole process path on a *P-v*, a *T-v* and a *P-T* diagram (clearly indicates the two-phase region.)

7) A mass of 12 kg of saturated refrigerant-134a vapor is contained in a piston-cylinder device at 200 kPa. Now 150 kJ of heat is transferred to the refrigerant at constant pressure while a 110V source supplies current to a resistor within the cylinder for 6 minutes. (Process A)

a. Determine the current supplied if the final temperature is 70 deg C.



b. If a latch is placed on the wall of the cylinder to restrain motion of the piston (Process B) from the beginning, what do you expect to be the main difference? Determine the current in this case.

c. Show the process on a *P-v*, a *T-v* and a *P-T* diagram (clearly indicates the two-phase region).

d. If the refrigerant is replaced by an ideal gas, how would you solve the problem differently?