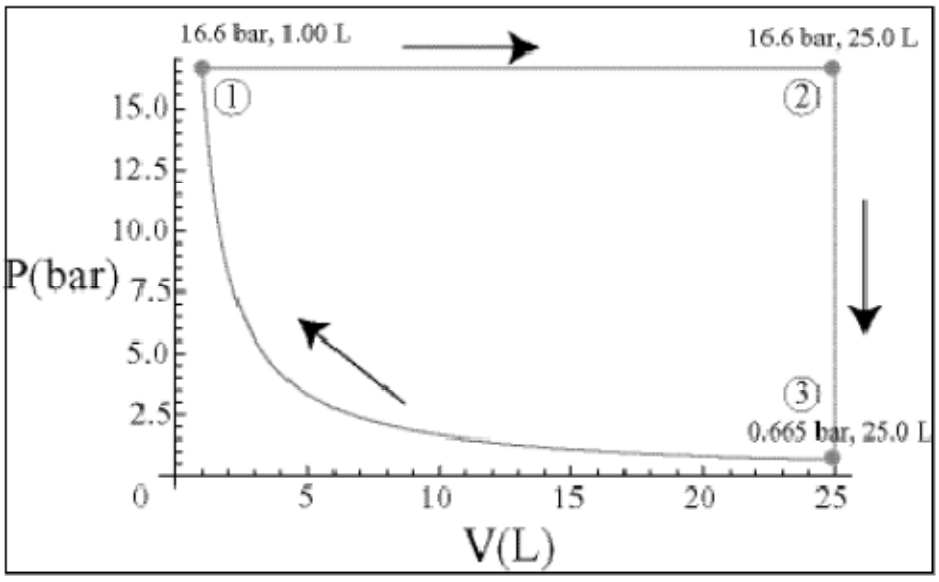
CHEN314 Thermodynamics II
Mid-term Exam (120 minutes)

Problem 1 [20 marks, 15 marks for part (a) and 5 for (b)]

A system containing 2.50 mol of an ideal gas for which C_V =20.79 $J\ mol^{-1}K^{-1}$ is taken through the cycle shown in the plot below in the direction indicated by the arrows. The curved path corresponds to $PV= nRT$, where $T=T_1=T_3$

a) Calculate q, w, and ΔU and ΔH for each segment, and for the cycle.

b) Calculate q, w, and ΔU and ΔH for each segment, and for the cycle in which the direction of each process is reversed.



Problem 2 [25 marks, 10 marks for part (a) and 15 marks for part (b)]

(a) From the Clapeyron equation derive an equation to express the vapor (saturation) pressure as a function of temperature. State your assumptions. The Clapeyron equation is given by:

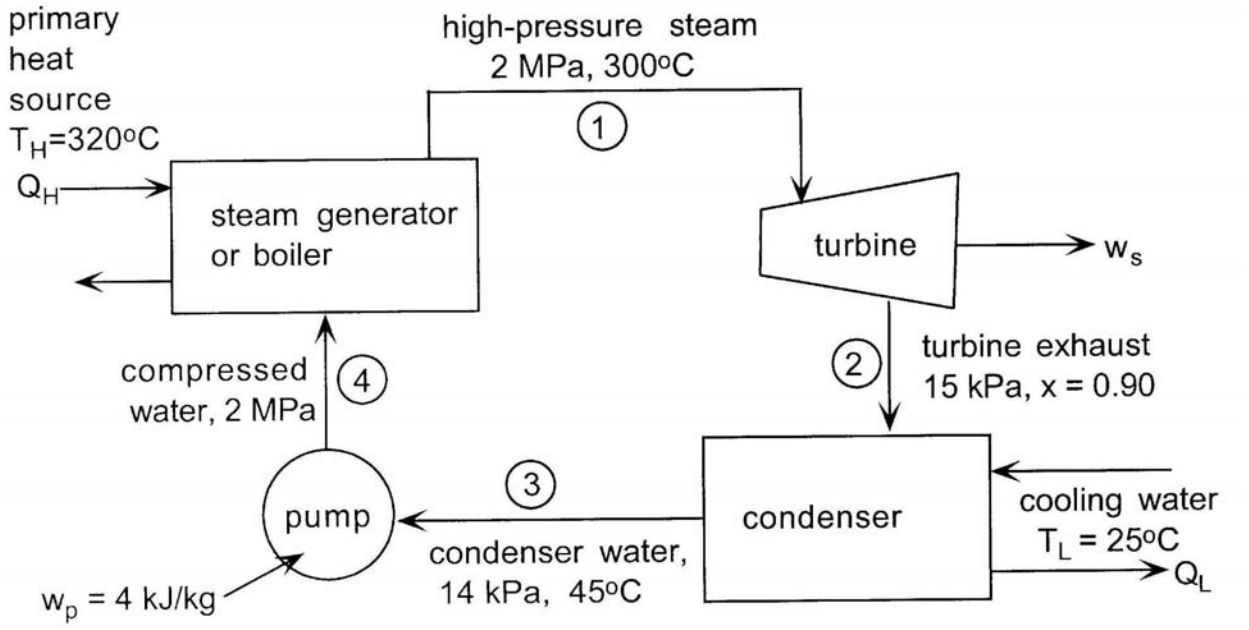
$$\frac{dP^{sat}}{dT} = \frac{\Delta S^{lv}}{\Delta v^{lv}}$$

(b) The normal boiling temperature of benzene is 80.1^oC, and the vapor pressure of liquid benzene is 10.4 kPa at 20.0^oC. Calculate (*i*) $\Delta H^{Vaporiztion}$ (*ii*) $\Delta S^{Vaporiztion}$ and (*iii*) the percentage error between the value obtained in part (*i*) and the experimentally determined heat of vaporization.

Problem 3 [30 marks, 15 marks for part (b) 3 marks for (a), (c)-(f)]

For the power cycle shown below (assume 100% efficiency for the pump and turbine):

(a) Sketch the cycle on a *T-S* diagram.
(b) Calculate the work produced by the turbine.
(c) Calculate the change in entropy of the surroundings.
(d) Calculate the overall efficiency.
(e) If the rating of the cycle is 20.0 MW what is the steam flow rate?
(f) Is the cycle below realistic? If yes, why and if no, then why not?



Problem 4 [25 marks, 5 marks for part (a) and 20 marks for part (b)]

Calculate the specific molar volume(s) in cm^3/mol of Carbon Tetrachloride at 5 bar and 320K using the following equations of state:

(a) The Van der Waals equation.
(b) The Peng-Robinson equation.

Bonus Problem [5 marks]

For the conditions specified in Problem 4 what is the stable condition for Carbon Tetrachloride: Liquid or gas? Provide a justification for your answer.