Problem T4. (Unified Thermodynamics)

A thermally-insulated piston-cylinder arrangement holds a thermally perfect gas at p_1 = 100kPa and T_1 = 300K. Assume that c_p = 1.0035 kJ/kg-K, c_v = 0.7165 kJ/kg-K, and R = 0.287 kJ/kg-K. You are to compare two processes.

a) The first process is an adiabatic, quasi-static compression from p_1 = 100kPa to p_2 = 500kPa. What are T_2 and v_2, and how much work was done by the system during this process?

b) For the second process, an external pressure of p=500kPa is instantaneously applied to the gas in the cylinder. What is the final state of the gas in the cylinder (T_2, v_2), and how much work was done by the system during the process?

c) Sketch both processes on a p_{ext}-v diagram. Which process is a more efficient means of compressing the gas to 500kPa and why?

(LO#4, LO#5)