Individual homework assignment #3.

1. A small, high-speed turbine operating on compressed air produces a power output of (100+N) W. The inlet state is (400+N) kPa (100+5*N) °C, and the exit state is (100+N) kPa. Assuming the velocities to be low and the process to be adiabatic, find the required mass flow rate of air through the turbine.
2. A monatomic gas is contained in a cylinder with a movable piston. Initially it has a volume V_0, pressure P_0 and temperature T_0. A weight is placed on the piston, and the gas is compressed adiabatically to a pressure $10P_0$. What is the final volume of the gas, and what is the final temperature? Express your answers in terms of V_0 and T_0 respectively.
3. For the same conditions, define the technical work value of the compression process. Compare it to technical work spent for cases with isothermal compression and two-stage adiabatic compression with isobaric cooling to initial temperature T_0.
4. Phil has a large cylinder filled with helium. It starts off with a volume of (1+N/10) liters, a pressure of 10^5 Pa, and a temperature of (300+N) K. He quickly decreases the volume to (N/10) liters adiabatically. Then, he waits for the gas to cool back down to (300+N) K at this volume. Finally, he expands the piston slowly out to (N/5) liters in such way that the temperature of the gas remains constant at (300+N) K. The three processes, adiabatic-isochoric-isothermal, form a cycle as shown in the figure. Calculate ΔU, Q, W_{by} and ΔS for each leg of the cycle, and for the whole cycle.