1. Air in a piston cylinder device is cooled ~~from~~ an initial state of pressure and temperature at 8.0 MPa and 700 °C, respectively, to a final state of temperature at 300 °C.

   (a) If the process is isobaric, using the gas properties from the "Ideal gas properties of air table", shown in the following, find the heat transfer (kJ/kg) and work (kJ/kg) done by the piston/cylinder assembly. **(20%)**

   (b) If the process is polytropic with n = 1.3, assuming ideal gas, find the final pressure. **(5%)**

   Gas constant of air, $R = 0.287$ kJ/kgK

Table1 Ideal gas properties of air

T (K)	h (kJ/kg)	u (kJ/kg)	s (kJ/kgK)
840	866.08	624.95	2.77170
860	888.27	641.40	2.79783
880	910.56	657.95	2.82344
900	932.93	674.58	2.84856
920	955.38	691.28	2.87324
940	977.92	708.08	2.89748
960	1000.55	725.02	2.92128
980	1023.25	741.98	2.94468
1000	1046.04	758.94	2.96770
1020	1068.89	776.10	2.99034
1040	1091.85	793.36	3.01260
1060	1114.86	810.62	3.03449

2. The inequality of Clausius is a corollary or a consequence of the 2nd law of thermodynamics. It states:

$$\oint\left(\frac{\delta Q}{T}\right)_b \leq 0 \begin{cases} = 0 \text{ applies when there are no internal irreversibilities,} \\ < 0 \text{ applies when internal irreversibilities are present,} \end{cases} \quad (1)$$

   where:

   (i) δQ represents the heat transfer at a part of the system boundary during a portion of the cycle, and T is the absolute temperature at that part of the boundary;

   (ii) the subscript "b" means the integrand is evaluated at the boundary;

   (iii) the notation "$\oint$ " indicates that the integrate is to be performed over all parts of the boundary and over the entire cycle.

   For a power cycle, demonstrate that in Eq. (1) the "=" is applicable to the reversible cycle and the "<" is applicable when the cycle is irreversible. **(10%)**