An **air-standard** Brayton cycle operates under the following conditions: compressor inlet: 100 kPa, 300 K; turbine inlet, 1 MPa, 1300 K.

(a) Find the heat transfer rate and power (per unit mass flow rate) for each device in the cycle.

(b) Find the cycle efficiency.

(c) What is the pressure ratio for the cycle?

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**Air-standard Brayton Cycle**

![Diagram of a Brayton cycle]

**FIND:**

- $\dot{W}_{\text{net}}$
- $\eta_{\text{th}}$
  - $\eta_p = \frac{P_2}{P_1} = 10 \quad \text{PART (c)}$

**SOLN:**

1-2: 

Energy - Work = (1/mass)

\[ 0 = h_2^0 + \dot{W}_{12} + (h_1 + \ldots) - (h_e + \ldots) \]

\[ \dot{W}_{12} = (h_e - h_2) \]

P3 = (P2/P1) P1

\[ h_1 = 300.19 \text{ kJ/kg} \]

\[ \delta_1 = 1.70203 \text{ kJ/kg-K} \]

P1 = 1.3800
\[ P_{r2} = \frac{1000}{100} (1.38) = 13.8 \quad \therefore \quad T_2 = 573.4 \, K \]
\[ h_2 = 579.2 \]
\[ \delta_2 = 2.3615 \]

\[ \dot{m}_{12} = (300.19 - 579.2) = +279.0 \, \text{kJ/kg} \]

2-3 Energy balance:
\[ q_{23} + \dot{m}_{23} = h_3 - h_2 \]
\[ h_3 = 1395.9 \, \text{kJ/kg} \]
\[ \delta_3 = 3.27245 \, \text{kJ/kg-K} \]
\[ P_{r3} = 330.9 \]

\[ q_{23} = 1395.9 - 579.2 = 816.8 \, \text{kJ/kg} \]

3-4
\[ \dot{m}_{34} = (h_3 - h_4) \]
\[ P_{r4} = \left( \frac{P_4}{P_3} \right) P_{r3} = \left( \frac{1000}{1000} \right) (330.9) = 330.9 \quad \text{(Isentropic)} \]
\[ \therefore \quad T_4 = 725.8 \, K \]
\[ h_4 = 741.1 \]
\[ \delta_4 = 2.61157 \]

4-0
\[ \delta_{41} = h_1 - h_4 = 300.19 - 741.1 = -440.9 \, \text{kJ/kg} \]

\[ \dot{m}_{\text{NET}} = (\dot{m}_{12} + \dot{m}_{34}) = (279.0 - 654.8) = 375.6 \, \text{kJ/kg} \]

\[ \eta_{\text{TH}} = \frac{\dot{m}_{\text{NET}}}{q_{\text{in}}} = \frac{375.6}{816.8} = 0.460 \]

\[ \delta_{41} = h_1 - h_4 = 300.19 - 741.1 = -440.9 \, \text{kJ/kg} \]