

$$T_1 = 300$$

$$P_1 = 100 = P_4$$

$$P_2 = P_3 = 700$$

$$T_2 = 580$$

$$q_{in} = 950$$

$$\text{Sol: } q_{in} = C_p (T_3 - T_2) \Rightarrow 950 = 1.005 (T_3 - 580)$$

$$\Rightarrow T_3 = 1525.27 \text{ K}$$

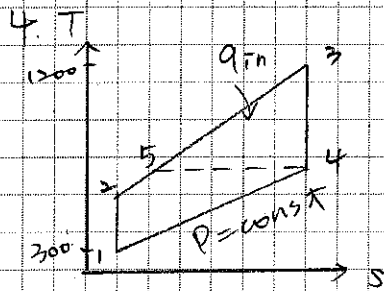
$$T_{4s} = T_3 \left( \frac{P_4}{P_3} \right)^{\frac{\gamma-1}{\gamma}} = 1525.27 \left( \frac{100}{700} \right)^{\frac{0.4}{1.4}} = 874.76 \text{ K}$$

$$W_{out} = (0.86) C_p (T_3 - T_{4s}) = (0.86) (1.005) (1525.27 - 874.76) = 562.24$$

$$W_{in} = C_p (T_2 - T_1) = (1.005) (580 - 300) = 281.4$$

$$\eta_{bw} = \frac{W_{in}}{W_{out}} = \frac{281.4}{562.24} = 50.05\% \quad \text{--- Ans.}$$

$$\eta_{th} = \frac{W_{net}}{q_{in}} = \frac{562.24 - 281.4}{950} = 29.56\% \quad \text{--- Ans}$$



$$r_p = 10 = \frac{P_2}{P_1} = \frac{P_3}{P_4}$$

$$\epsilon_{\text{regen}} = 100\%$$

$$\text{Sol: } T_2 = T_1 \left( \frac{P_2}{P_1} \right)^{\frac{k-1}{k}} = 300 (10)^{\frac{0.4}{1.4}} = 579.21$$

$$T_4 = T_3 \left( \frac{P_4}{P_3} \right)^{\frac{k-1}{k}} = 1200 \left( \frac{1}{10} \right)^{\frac{0.4}{1.4}} = 621.54$$

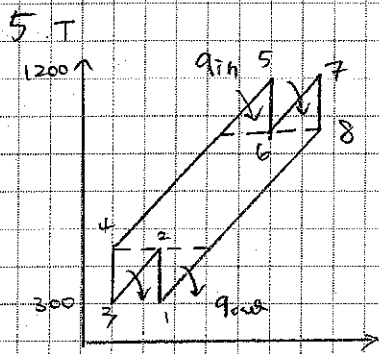
$$W_{\text{out}} = C_p (T_3 - T_4) = 1.005 (1200 - 621.54) = 581.35$$

$$W_{\text{in}} = C_p (T_2 - T_1) = 1.005 (579.21 - 300) = 280.61$$

$$W_{\text{net}} = W_{\text{out}} - W_{\text{in}} = 300.74 \frac{\text{kJ}}{\text{kg}} \text{ --- Ans}$$

$$\begin{aligned} q_{\text{in}} &= C_p (T_3 - T_2) - C_p (T_4 - T_1) \\ &= 1.005 (1200 - 579.21) - 1.005 (621.54 - 300) \\ &= 581.35 \end{aligned}$$

$$\eta = \frac{300.74}{581.35} = 51.73\% \text{ --- Ans}$$



$$r_p = 3 = \frac{P_2}{P_1} = \frac{P_4}{P_3} = \frac{P_5}{P_6} = \frac{P_7}{P_8}$$

$$T_1 = T_3 = 300$$

$$T_5 = T_7 = 1200$$

$$\text{Sol: } T_2 = T_1 \left( \frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}} = 300 (3)^{0.4} = 410.62 = T_2 = T_4$$

$$T_6 = T_5 \left( \frac{P_6}{P_5} \right)^{\frac{\gamma-1}{\gamma}} = 1200 \left( \frac{1}{3} \right)^{0.4} = 876.72 = T_6 = T_8$$

$$W_{in} = C_p (T_2 - T_1) \times 2 = (1.005) (410.62 - 300) \times 2 = 222.34$$

$$W_{out} = C_p (T_5 - T_6) \times 2 = (1.005) (1200 - 876.72) \times 2 = 646.56$$

$$\eta_{ow} = \frac{222.34}{646.56} = 34.39\% \quad \text{--- Ans:}$$

$$W_{net} = 646.56 - 222.34 = 424.22$$

$$\begin{aligned} \text{a) } q_{in} &= C_p (T_5 - T_4) + C_p (T_7 - T_6) \\ &= 1.005 (1200 - 410.62) + 1.005 (1200 - 876.72) \\ &= 1118.22 \end{aligned}$$

$$\eta_{th} = \frac{424.22}{1118.22} = 37.94\% \quad \text{--- Ans:}$$

$$\begin{aligned} \text{b) } q_{in, gen} &= q_{in} - (0.75) (T_8 - T_4) \cdot C_p \\ &= 1118.22 - (0.75) (1.005) (876.72 - 410.62) \\ &= 766.88 \end{aligned}$$

$$\eta_{th} = \frac{424.22}{766.88} = 55.32\% \quad \text{--- Ans:}$$