1 → 2 → 3 → 4 (regen) → 5 (q_{in}) → 6 → 7 → 8 (q_{in})

$P_1 = 100 kPa$
$T_1 = 290.15K$
$V_1 = 0.833$

$V_1 = \frac{RT_1}{P_1}$

$P_2 = r_p P_1$
$P_2 = 400 kPa$

$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$

$T_2 = 431.16K$

$V_2 = \frac{RT_2}{P_2} = 0.31$

$P_3 = P_2$
$P_3 = 400 kPa$

$T_3 = T_1$
$T_3 = 290.15K$

$V_3 = \frac{RT_3}{P_3}$
$= 0.21$

$P_4 = r_p P_3$
$P_4 = 1600 kPa$

$\frac{T_4}{T_3} = \left(\frac{P_4}{P_3}\right)^{\frac{k-1}{k}}$

$T_4 = 431.08K$

$V_4 = 0.077$

$P_5 = P_4$
$P_5 = 1600 kPa$

$T_5 = T_4 + 20$
$T_5 = 451.08K$

$V_5 = 0.061$

$P_6 = P_5$
$P_6 = 1600$

$q_{in_{5-6}} = c_p(T_6 - T_5)$
$q_{in_{5-6}} = 300$

$T_6 = 749.61$
$V_6 = 0.134$

$P_7 = P_6 / r_p$
$P_7 = 400 kPa$

$T_8 = T_7 + \frac{q_{in}}{c_p}$
$T_8 = 803.08$

$V_8 = 0.876$

$P_8 = P_{10}$
$P_9 = 100 kPa$

$\frac{T_9}{T_8} = \left(\frac{P_9}{P_8}\right)^{\frac{k-1}{k}}$

$T_9 = 540.51$

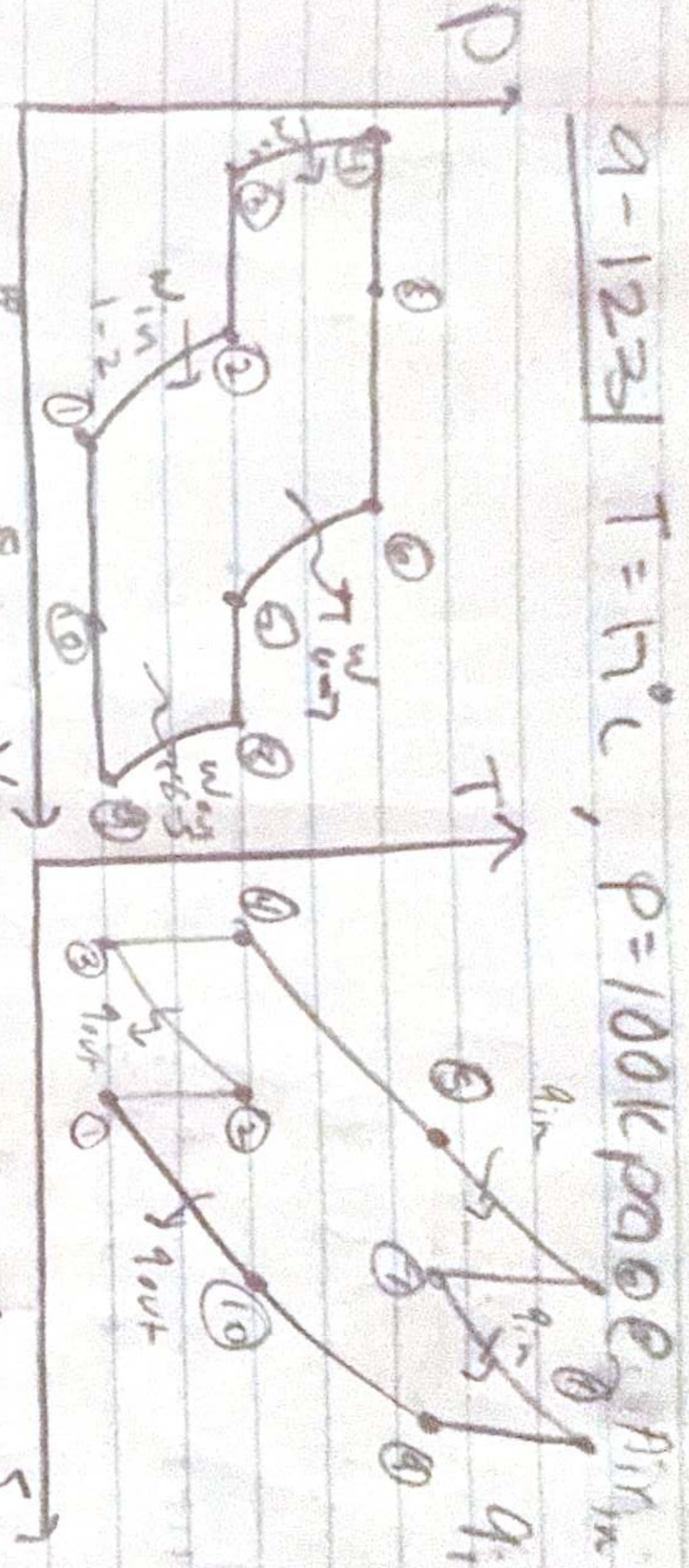
$\frac{T_7}{T_6} = \left(\frac{P_7}{P_6}\right)^{\frac{k-1}{k}}$

$T_7 = 804.55$
$V_7 = 0.362$

9 → 10 (regen)

$P_9 = P_{10}$
$P_9 = 100 kPa$
$T_9 = 540.51K$

$P_{10} = P_1$
$P_{10} = 100 kPa$
$V_{10} = 1.494$
$T_{10} = 520.51K$



$P = 100 kPa$ @ $T = 7°C$

$r_p = 4$

9-123 cont'd)

$$\eta_{th} = \frac{W_{net}}{q_{in}}$$

$$W_{net} = W_{out_{6\to7}} + W_{out_{8\to7}} - W_{in_{1\to2}} - W_{in_{3\to4}}$$

$$W_{out_{6\to7}} = c_p(T_6 - T_7) = 246.26$$

$$W_{out_{8\to7}} = c_p(T_8 - T_7) = 263.86$$

$$W_{in_{1\to2}} = c_p(T_2 - T_1) = 141.70$$

$$W_{in_{3\to4}} = c_p(T_4 - T_3) = 141.62$$

$$W_{net} = 226.401$$

$$q_{in} = q_{in} + q_{in} = 300\frac{kj}{kg} + 300\frac{kj}{kg}$$

$$q_{in} = 600 kj/kg$$

$$\eta_{th} = 0.378$$

1 FPS = 0.3048

400 × 0.3048

= 274.32 m/s

$k = \frac{R}{1.4} \rightarrow \frac{2400}{1.4}$

20,000 ft = 18,26 kPa = 260.93 K

$T_{Turn,in}$ = 2400 R

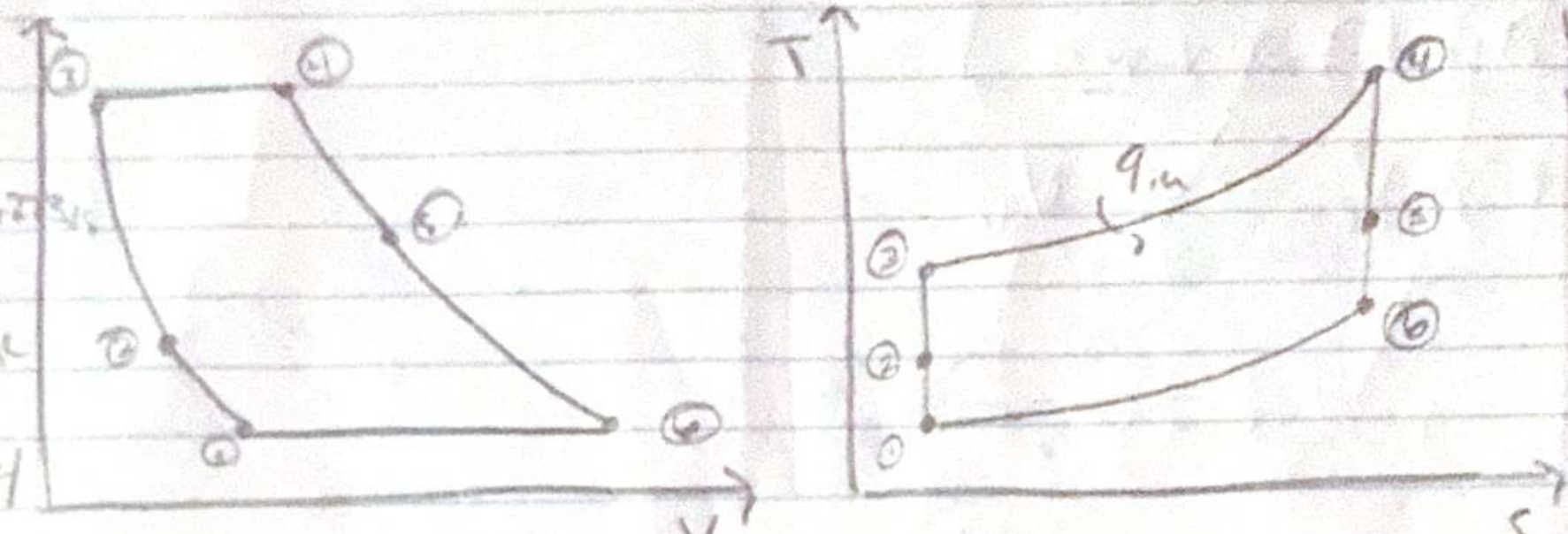
↳ 1333.33 K

9-129 $r_p = 13$ V = 900 FPS $C_p = 1.005$

$C_v = 0.718$

$k = 1.4$

$R = .2870$



$P_{sl} = 6.894$

$7 \times 6.894 = 48.26$

1 Isent → 2 Isent → 3 P const → 4 Isent → 5 Isent → 6

$P_1 = 48.26 kPa$ ✓

$T_1 = 260.93 K$ ✓

$\sqrt{1} = 1.55$ ✓

$V_1 = 274.32 m/s$ ✓

$P_3 = 13 P_2$ $P_4 = 1003.08$ ✓

$P_3 = 1003.08$ ✓ $T_4 = 1333.33 K$ ✓

$T_3 = 619.76 K$ ✓

$\sqrt{3} = 0.177$ ✓ $\sqrt{4} = 0.581$ ✓ $V_5 = 0 m/s$

$P_6 = 48.26$ ✓

$T_6 = 779.76$

$\sqrt{6} = 4.6$ ✓

$V_1 = \frac{RT_1}{P_1}$

$= \frac{(.2870)(260.93)}{(48.26)}$

$P_2 = 77.16 kPa$ ✓

$T_2 = 298.37$ ✓

$\sqrt{2} = 1.109$ ✓

$V_2 = 0 m/s$ ✓

$\frac{T_3}{T_2} = \left(\frac{P_3}{P_2}\right)^{\frac{1.4-1}{1.4}}$

$T_3 = T_2 \left(\frac{P_3}{P_2}\right)^{\frac{k-1}{k}}$

$\frac{P_5}{P_4} = \left(\frac{T_5}{T_4}\right)^{\frac{k}{k-1}}$

$P_5 = 382.14$

$V = \frac{RT}{P}$

$\frac{V_1^2}{2} + h_1 = C_p(T_2 - T_1)$

$T_2 = T_1 + \frac{V_1^2}{2C_p}$

$T_2 = 260.93 + \frac{(274.32)^2}{2(1.005)}$

$T_3 = (298.37)\left(\frac{1003.08}{77.16}\right)^{.285}$

$V_3 = \frac{RT_3}{P_3}$ $V_4 = \frac{RT_4}{P_4}$ $V_6 = \frac{RT_6}{P_6}$

$T_5 = T_4 - (T_3 - T_2)$

$= 1333.3 - (619.76 - 298.37)$

$T_5 = 1012.03$ ✓

$P_5 = 382.14$ ✓

$V_5 = .76$ ✓

$\frac{T_6}{T_5} = \left(\frac{P_6}{P_5}\right)^{\frac{k-1}{k}}$

$V_5 = 0 m/s$ ✓

$\frac{P_2}{P_1} = \left(\frac{T_2}{T_1}\right)^{\frac{k}{k-1}}$

$P_2 = P_1\left(\frac{T_2}{T_1}\right)^{3.5}$

$= (48.26)\left(\frac{298.37}{260.93}\right)$

$V_5 = \frac{RT_5}{P_5}$

9-129 cont'd

a) 77.1 kPa

b) $V_{exhaust\ Gases} = V_6$

$$\frac{V_5^2}{2} + h_5 = \frac{V_6^2}{2} + h_6$$

$$\frac{V_6^2}{2} = C_p(T_5 - T_6)$$

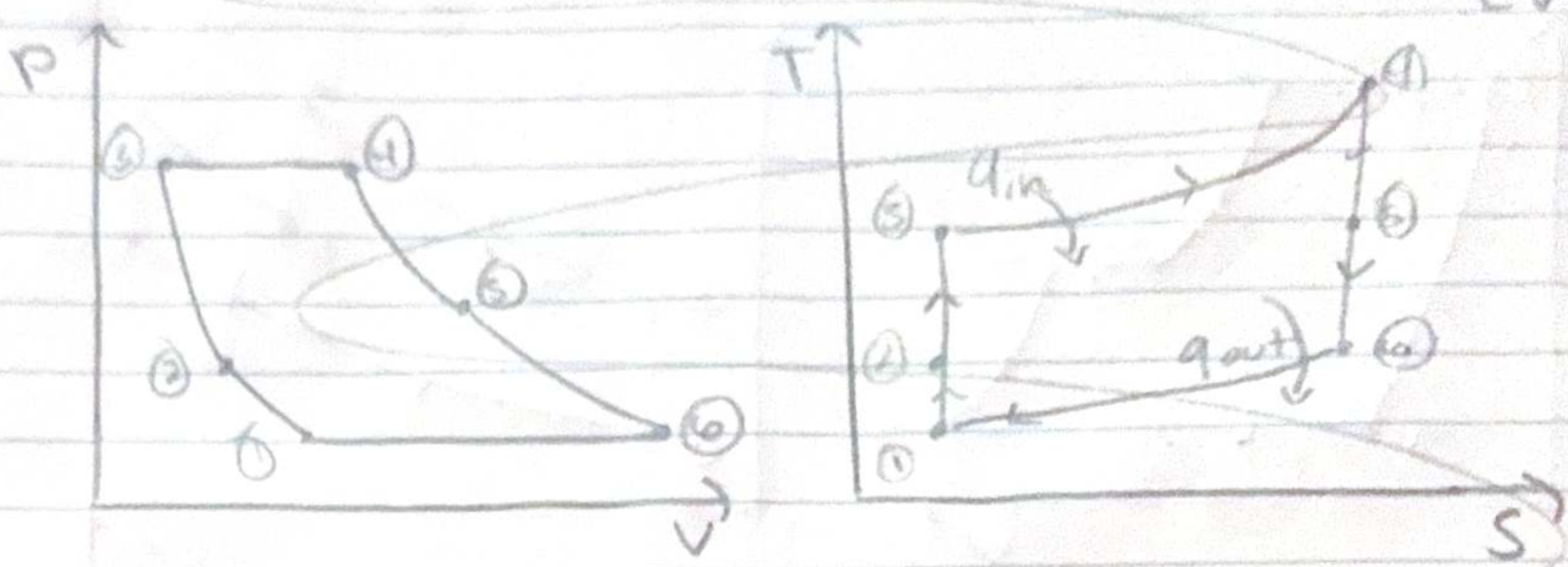
$$V_6 = \sqrt{C_p(T_5 - T_6)}$$

$$V_6 = \sqrt{1.005(1012.03 - 779.76}$$

$$V_6 = 15.27 \text{ m/s}$$

c) $\eta_p = \frac{\dot{W}_p}{\dot{Q}_{in}}$

9-135 | $r_p = 9$ $\dot{m}_{air} = 20$ $\dot{m}_{exit} = 0.5$ $C_p = 1.005$
$C_v = .718$
$R = .287$
$k = 1.4$



1 Isent 2 Isent 3 P const 4 Isent 5 Isent 6
P const

$P_1 = 95 kPa$ $P_2 = 855$ $P_3 = 769.5$ $P_4 =$ $P_5 =$ $P_6 = 95 kPa$
$T_1 = 7°C \rightarrow 280.15K$ $T_2 = 524.0K$ $T_3 = 1459$ $T_4 =$ $T_5 =$ $T_6 =$
$P_3 = 9P_2$

Table A-17

$h_1 = 280.13$ $h_2 = 525.3$ $h_3 = 1593$ $h_4 =$ $h_5 =$ $h_6 =$
$P_{r_1} = 1.0889$ $P_{r_2} = 9.8$ $P_{r_3} = 551$ $P_{r_4} =$ $P_{r_5} =$ $P_{r_6} =$
↑ Interpolate

$\frac{P_2}{P_1} = \frac{P_{r_2}}{P_{r_1}}$

$P_{r_2} = P_{r_1}\left(\frac{P_2}{P_1}\right)$

$= 9.7$

$\dot{Q}_{in} = \dot{m} l + v$

$\dot{Q}_{in} = 0.5(42{,}700)$
$= 21350 kw$

$q_{in} = \frac{21350}{20} \rightarrow 1067.5$

$q_{in} = h_3 - h_2$
$1067.5 = h_3 - 525.3$
$h_3 = 1593$

$r_p = \frac{P_2}{P_1}$

$q = \frac{P_2}{as}$

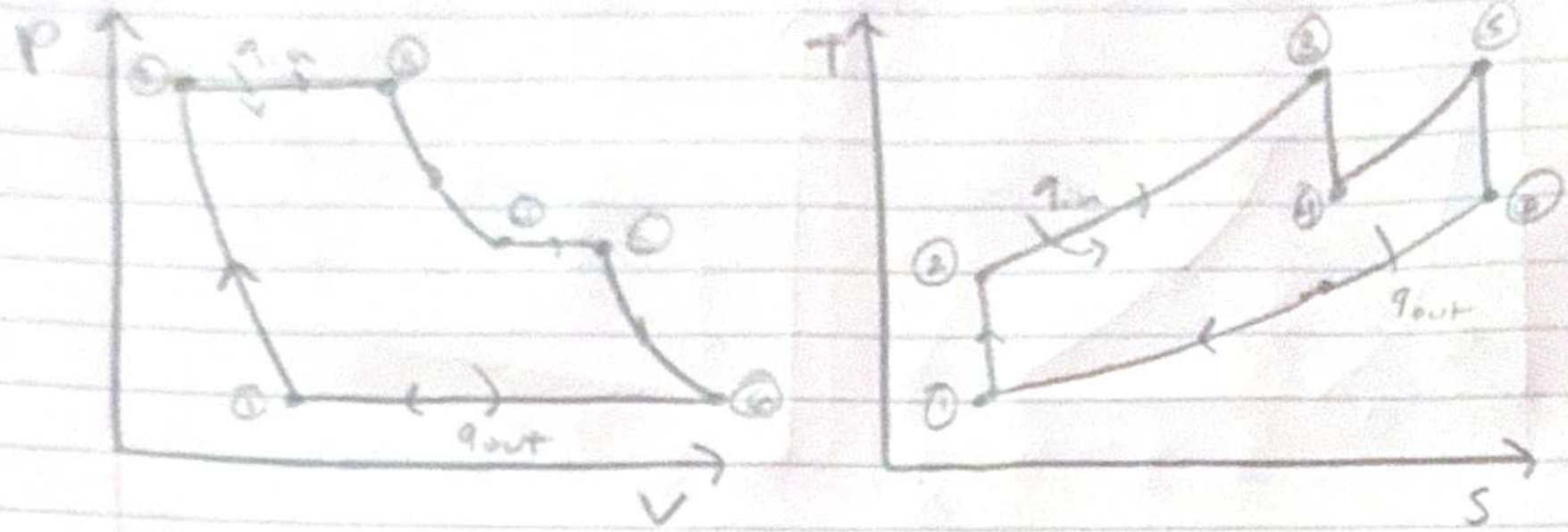
$T_2 = T_1\left(\frac{P_2}{P_1}\right)^{k-1/k}$

$q_{in} = C_p(T_3 - T_2)$

$T_3 = \frac{q_{in}}{C_p} + T_2$

✱ confusion when looking for Variable At Stage 4! Started to overthink whether this cycle has 4 or 6 Stages ✱

9-107 $r_c = \frac{P_2}{P_1}$



① Isent ② P const ③ Isent ④ P const ⑤ Isent ⑥ P const ①

$P_1 = P_6$ ✓ $P_2 = P_3$ ✓ $P_3 = P_2$ ✓ $P_4 = P_5$ ✓ $P_5 = P_4$ ✓ $P_6 = P_1$ ✓

$T_1 =$ ✓ $T_2 =$ ✓ $T_3 =$ ✓ $T_4 =$ ✓ $T_5 =$ ✓ $T_6 =$ ✓

$V_1 =$ ✓ $V_2 =$ ✓ $V_3 =$ ✓ $V_4 =$ ✓ $V_5 =$ ✓ V_6 ✓

$\frac{P_2}{P_1} = \frac{P_4}{P_3}$ $T_2 = T_1\left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$ $T_4 = T_3\left(\frac{P_4}{P_1}\right)^{\frac{k-1}{k}}$ $T_6 = T_5\left(\frac{P_6}{P_5}\right)^{\frac{k-1}{k}}$

$V_1 = \frac{RT}{P}$ $V_2 = \frac{RT_2}{P_2}$ $T_3 =$ $V_4 = \frac{RT_4}{P_4}$ $V_6 = \frac{RT_6}{P_6}$

$\eta_{th} = \frac{W_{net}}{q_{in}}$ $V_3 = \frac{RT_3}{P_3}$ $T_5 = T_4\left(\frac{P_5}{P_4}\right)^{\frac{k-1}{k}}$

$q_{in} = C_p(T_3 - T_2)$ $V_5 = \frac{RT_5}{P_5}$

$T_3 = \frac{q_{in} + T_2}{C_p}$ * not sure on what solving for? *

$q_{out} = C_p(T_6 - T_1)$

$\eta_{th} = 1 - \frac{T_6 - T_1}{T_3 - T_2}$