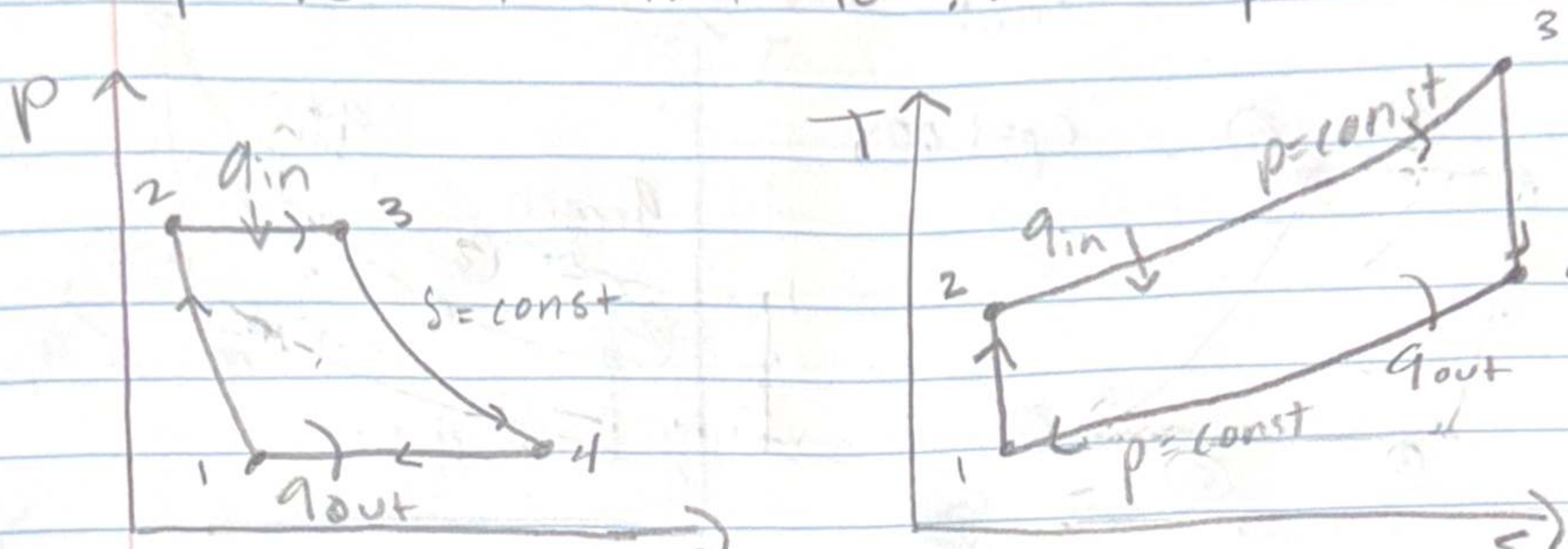
HW 1.4

9-856 | Ideal Brayton Cycle

Mizell
Smalls

$r_p = 10$ $k = 1.4$ $R = .287$ $C_p = 1.005$ $C_v = .718$




$q_{in} = 500kw$

$\dot{m} = 1kg/s$

1 Isentropic 2 P const 3 Isentropic 4

Constant P

$P_1 = 70kPa$ $P_2 = 700kPa$ $P_3 = 700kpa$ $P_4 = 70kPa$

$T_1 = 273K$ $T_2 = 527K$ $T_3 = 1024K$ $T_4 = 530K$

$V_1 = 1.119$ $V_2 = 0.216$ $V_3 = 0.419$ $V_4 = 2.173$

$k-1/k = .2857$

$P_2 = r_p \times P_1$

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

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

$PV = RT$

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

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

$W_{net} = C_p[(T_3 - T_2) - (T_4 - T_1)]$

$= 1.005[(497) - (257)]$

$W_{net} = 241.2$

$\dot{W}_{net} = \dot{m} \cdot W_{net}$

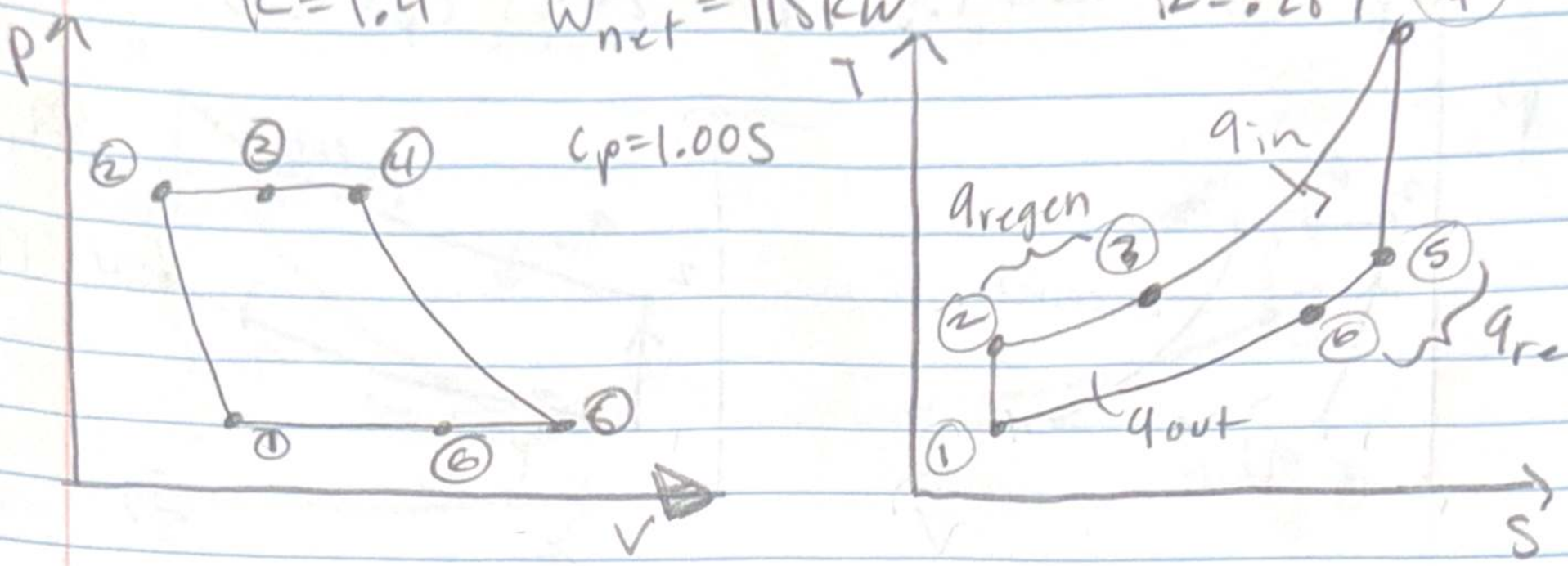
$= 1 \cdot 241.2$

$\boxed{\dot{W}_{net} = 241.2}$

$\boxed{\eta_{th} = \frac{241.2}{500kw} \rightarrow 0.4824}$

9-99 | $r_p = 10$ $T_{max} = 800°C \rightarrow 1073K$

$k = 1.4$ $\dot{W}_{net} = 115kW$ $R = .287$




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

| ① | ② | ③ | ④ | ⑤ | ⑥ |
|---|---|---|---|---|---|
| $P_1 = 100kpa$ | $P_2 = 1000$ | $P_3 = 1000$ | $P_4 = 1000$ | $P_5 = 100kpa$ | $P_6 = 100kpa$ |
| $T_1 = 303K$ | $T_2 = 584.9$ | $T_3 = 545.7$ | $T_4 = 1073K$ | $T_5 = 555.7K$ | $T_6 = 594.9K$ |
| $V_1 = .86$ | $V_2 = .167$ | $V_3 = .156$ | $V_4 = .307$ | $V_5 = 1.59$ | $V_6 = 1.707$ |

$PV = RT$

$(k-1)/k$

$= .2857$

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

$P_2 = r_p P_1$

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

$T_3 = T_5 - 10$

$P_2 = P_3 = P_4$

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

$P_6 = P_1$

$q_{in} = C_p(T_4 - T_3)$
$= 1.005(1073 - 845.7)$
$= 829.93$

$q_{out} = C_p(T_6 - T_1)$
$= 1.005(594.9 - 303)$
$= 293.35$

$\dot{W}_{net} = \dot{m}(q_{in} - q_{out})$

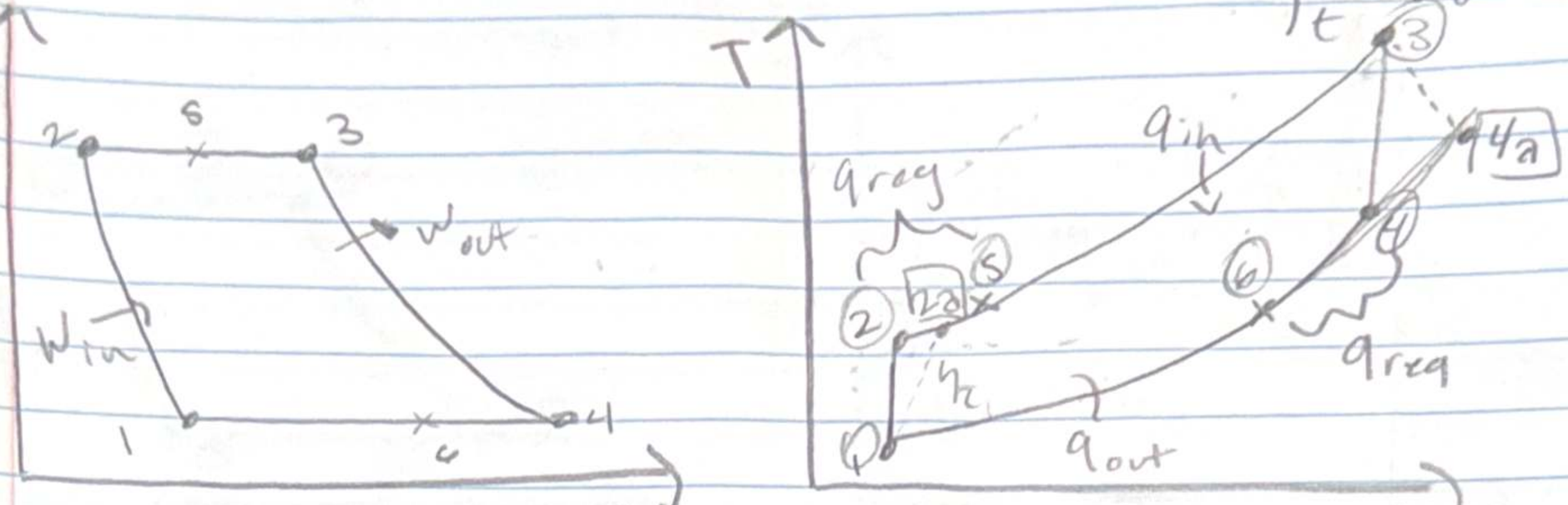
$\dot{m} = \frac{115}{829.9 - 293.35}$

$\dot{m} = .486$

$\dot{Q}_{out} = \dot{m} q_{out}$
$= (.486)(293.35)$
$= 142.5681 kW$

$\dot{Q}_{in} = \dot{m} q_{in}$
$= (.486)(829.93)$
$= 257.84 kW$

9-107 | $r_p = 7$ $T_{min} = 310K$ $T_{max} = 1150K$ $\epsilon = .65$ $\eta_c = .75$ $\eta_t = .82$




| | | | | | | |
|---|---|---|---|---|---|---|
| using Table A-17 | $T_1 = 310K$ | $P_2 = 7P_1$ | $h_5 = 738.4$ | $h_3 = 1219.2$ | $h_4 = 711.7$ | $h_{4a} = 803.14$ |
| | $P_{r1} = 1.554$ | $T_2 = 537$ | $P_5 = P_2$ | $T_3 = 1150K$ | $P_4 = P_1$ | $P_6 = P_1$ |
| | $h_1 = 310.24$ | $h_{2a} = 618.2$ | $T_5 = 723.3$ | $P_3 = P_2$ | $T_4 = 698.6$ | $T_6 = 671.71$ |
| | | $T_{2a} = 610.7$ | | $P_{r3} = 200.15$ | $P_{r4} = 2859$ | $h_6 = 682.97$ |
| | | | | | | → A-17 |

$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$ $\epsilon = \frac{T_5 - T_{2a}}{T_{4a} - T_{2a}}$ $\frac{T_4}{T_3} = \left(\frac{P_4}{P_3}\right)^{\frac{k-1}{k}}$ $\frac{P_4}{P_3} = \frac{P_{r4}}{P_{r3}}$

$\frac{P_2}{P_1} = \frac{P_{r2}}{P_{r1}} \rightarrow P_{r2} = 10.82 \xrightarrow{A-17} h_2$

$T_5 = 702.16K$ $pr3 \Rightarrow A-17$

A) $T_{Turb\ out} = T_{4a} = 747.82K$ A-17*

B) $W_{net} = C_p(T_3 - T_{4a}) - C_p(T_{2a} - T_1)$

C) $\eta_{th} = \frac{W_{net}}{q_{in}}$, $q_{in} = C_p(T_3 - T_5)$

$\eta_c = \frac{h_2 - h_1}{h_{2a} - h_1} \rightarrow h_2$ $\epsilon = \frac{h_5 - h_{2a}}{h_{4a} - h_{2a}}$

$T_{2a} \Rightarrow A-17$ $P_5 = P_2$ $h_5 = 738.4$

$P_{r4} = 28.513$
$T_4 = 698.63K$
A-17 ⇒

h3 → A-17

| A-17 |
|---|
| $T_{4A} = 782.84$ |

A-17
$T_5 = 723.3$

9-107 (cont'd)

$W_{net} = W_{out} - W_{in}$

$W_{out} = h_3 - h_{4a} = 4116.10$

$W_{in} = h_{2a} - h_1 = 308.03$

$\boxed{W_{net} = 108.075}$

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

$q_{in} = h_3 - h_5 = 480.81$

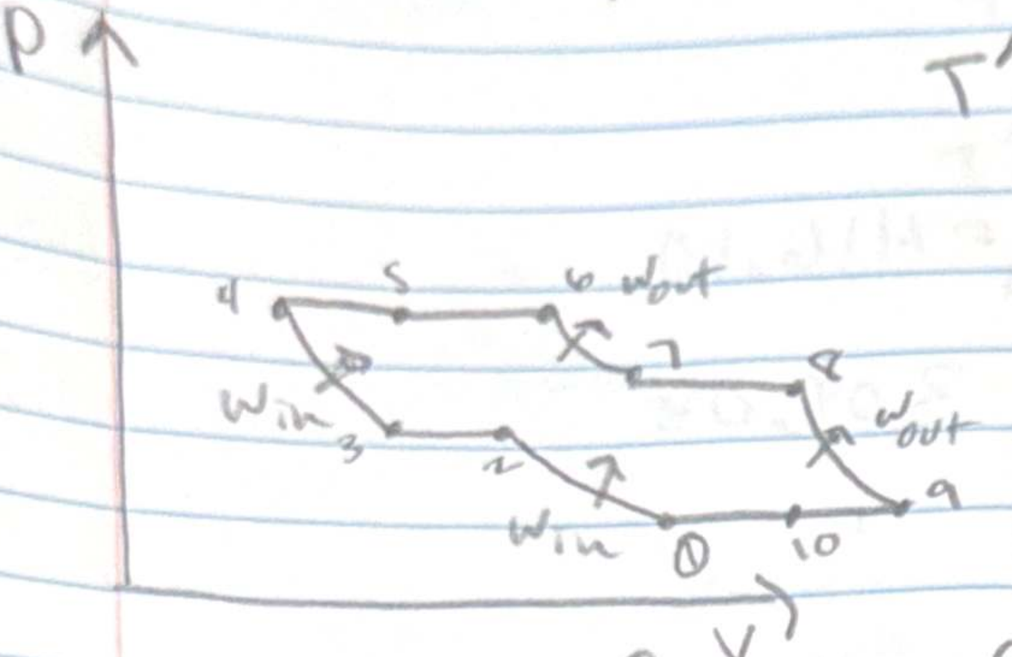
$\eta_{th} = \frac{108.075}{480.81}$

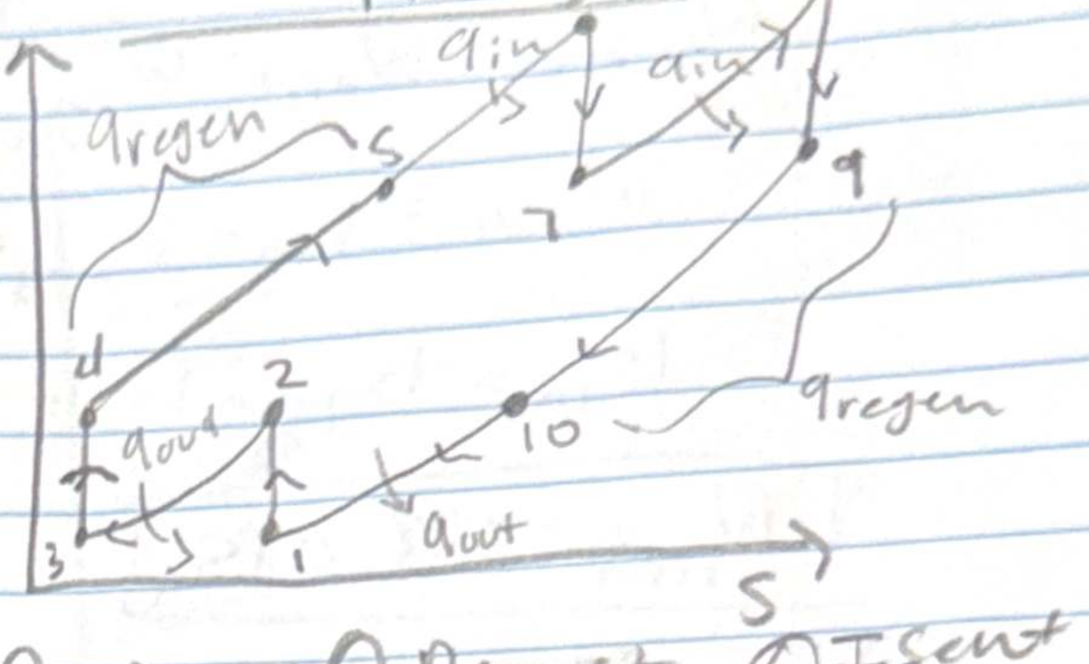
$\boxed{= 0.225}$

From A-17
$h = 300.19$
$P_r = 1.38$

$\frac{P_2}{P_1} = \frac{P_4}{P_3}$ & $\frac{P_6}{P_7} = \frac{P_8}{P_9}$

9-119 | $r_p = 9$ $\quad r_p = 4 = \frac{P_2}{P_1} = \frac{P_4}{P_3}$




① Isen ② Pconst ③ Isent ④ Pconst regen ⑤ Pconst qin ⑥ Isent

$T_1 = 300K$ $\quad P_2 = 9P_1$ $\quad T_3 = 300K$ $\quad T_6 = 1200K$

$P_{r_1} = 1.38$

$p_2 = p_3$ $\quad p_4 = p_5 = p_6$

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

$T_4 = T_2 = T_{10}$

$T_5 = T_7 = T_9$

⑥ Isentropic ⑦ Pconst qin ⑧ Isent ⑨ Pconst regen ⑩ Pconst →

$T_9 = 1200K$

$p_7 = p_8$ $\quad p_9 = p_{10} = p_1$

* Confusion on Solving for Some Stages *