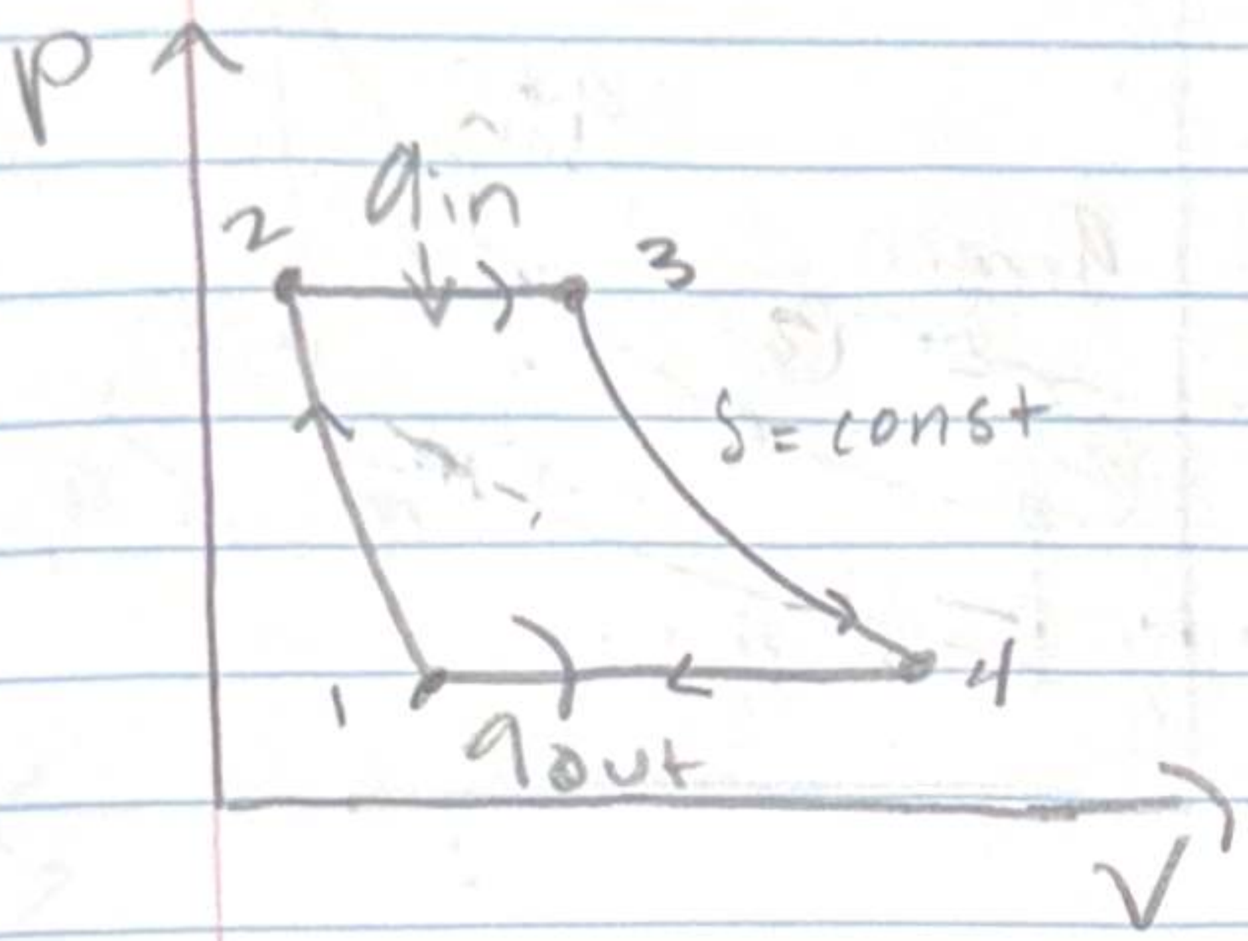
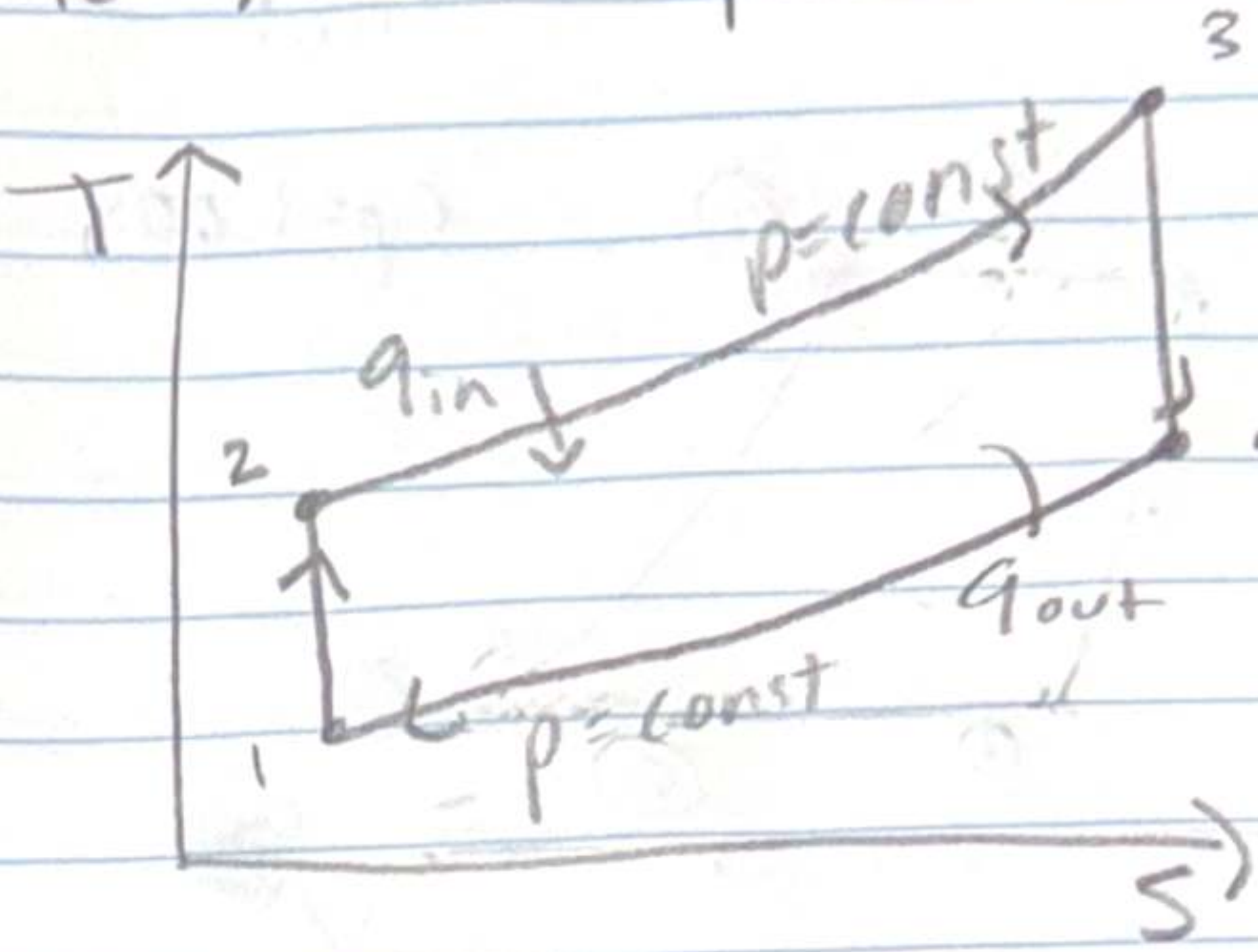
Hw 1.4 Mizell Smalls

9-88 | Ideal Brayton Cycle

$r_p = 10$ $k = 1.4$ $R = .287$ $c_p = 1.005$ $c_v = .718$





$q_{in} = 500kw$

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

1 Isentropic → 2 p const → 3 Isentropic → 4

Constant P (4 → 1)

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

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

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

$P_2 = r_p \times P_1$

$k-1/k = .2857$

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

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

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

$PV = RT$

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

$W_{net} = c_p[(T_3 - T_2) - (T_4 - T_1)]$
$= 1.005[(497) - (257)]$

$W_{net} = 241.2$

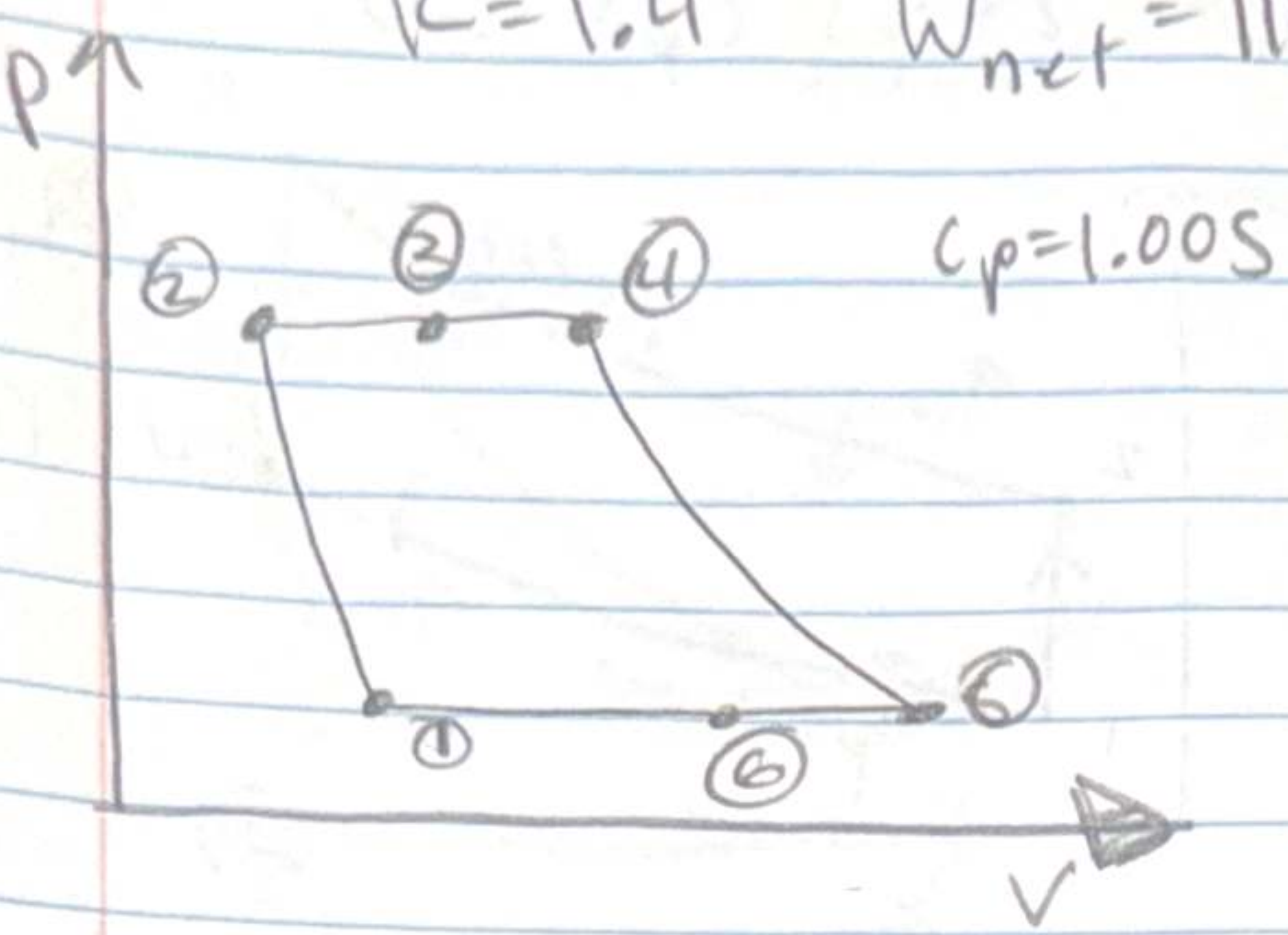
$\dot{W}_{net} = \dot{m} \cdot W_{net}$
$= 1 \cdot 241.2$

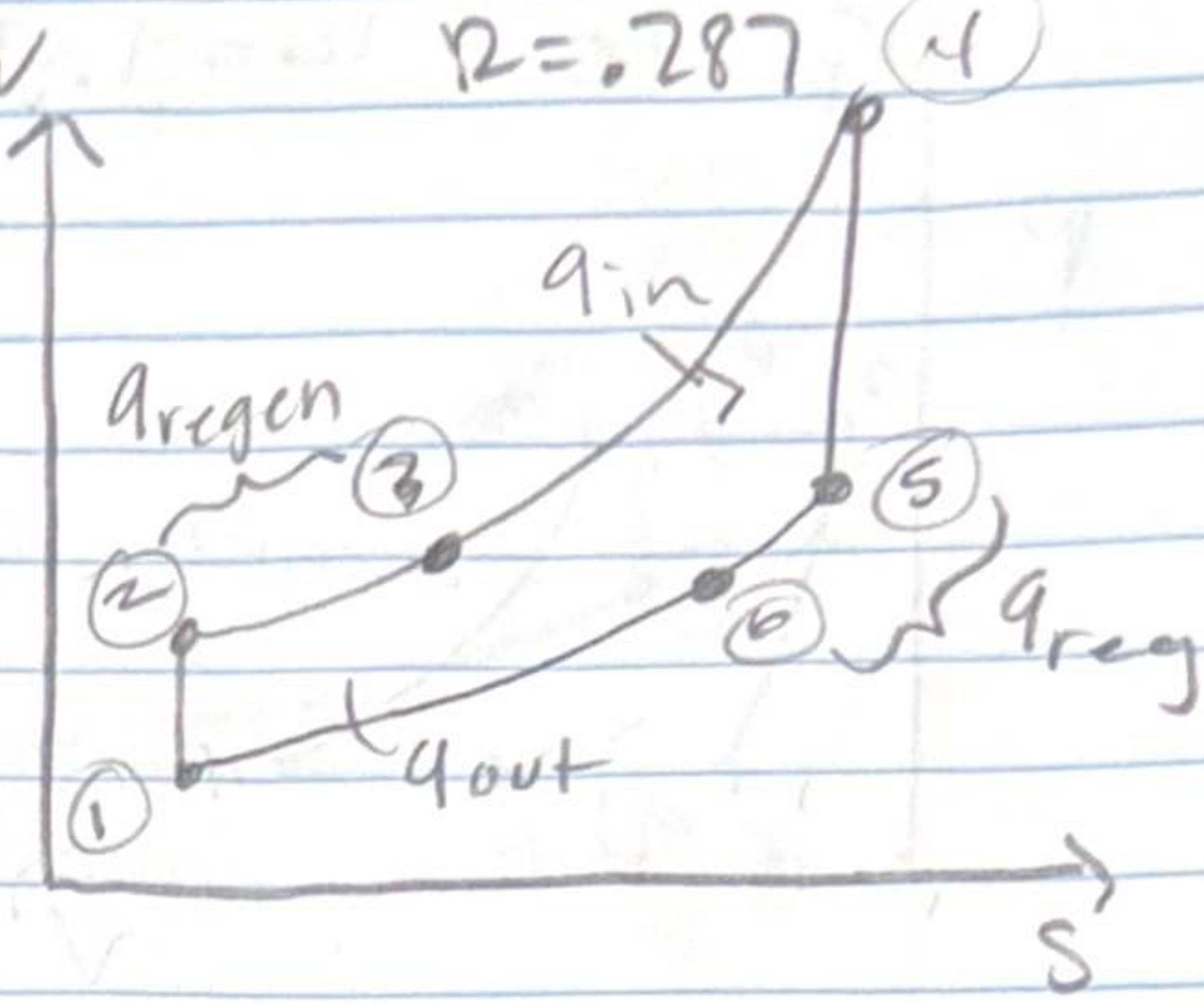
$\boxed{\dot{W}_{net} = 241.2}$

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

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

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





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

$P_1 = 100 kPa$	$P_2 = 1000$	$P_3 = 1000$	$P_4 = 1000$	$P_5 = 100 kPa$
$T_1 = 303 K$	$T_2 = 584.9$	$T_3 = 545.7$	$T_4 = 1073 K$	$T_5 = 555.7 K$
$V_1 = .86$	$V_2 = .167$	$V_3 = .156$	$V_4 = .307$	$V_5 = 1.59$

$PV = RT$

$(k-1)/k = .2857$

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

$P_2 = r_p P_1$

$T_3 = T_5 - 10$

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

$P_2 = P_3 = P_4$

$P_6 = 100 kPa$
$T_6 = 594.9 K$
$V_6 = 1.707$

$\frac{T_5}{T_4} = \left(\frac{P_5}{P_4}\right)^{\frac{k-1}{k}}$ $P_6 = P_1$

$q_{in} = C_p(T_4 - T_3)$
$= 1.005(1073 - 845.7)$
$= 529.93$

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

$\dot{m} = \frac{115}{529.9 - 293.35}$

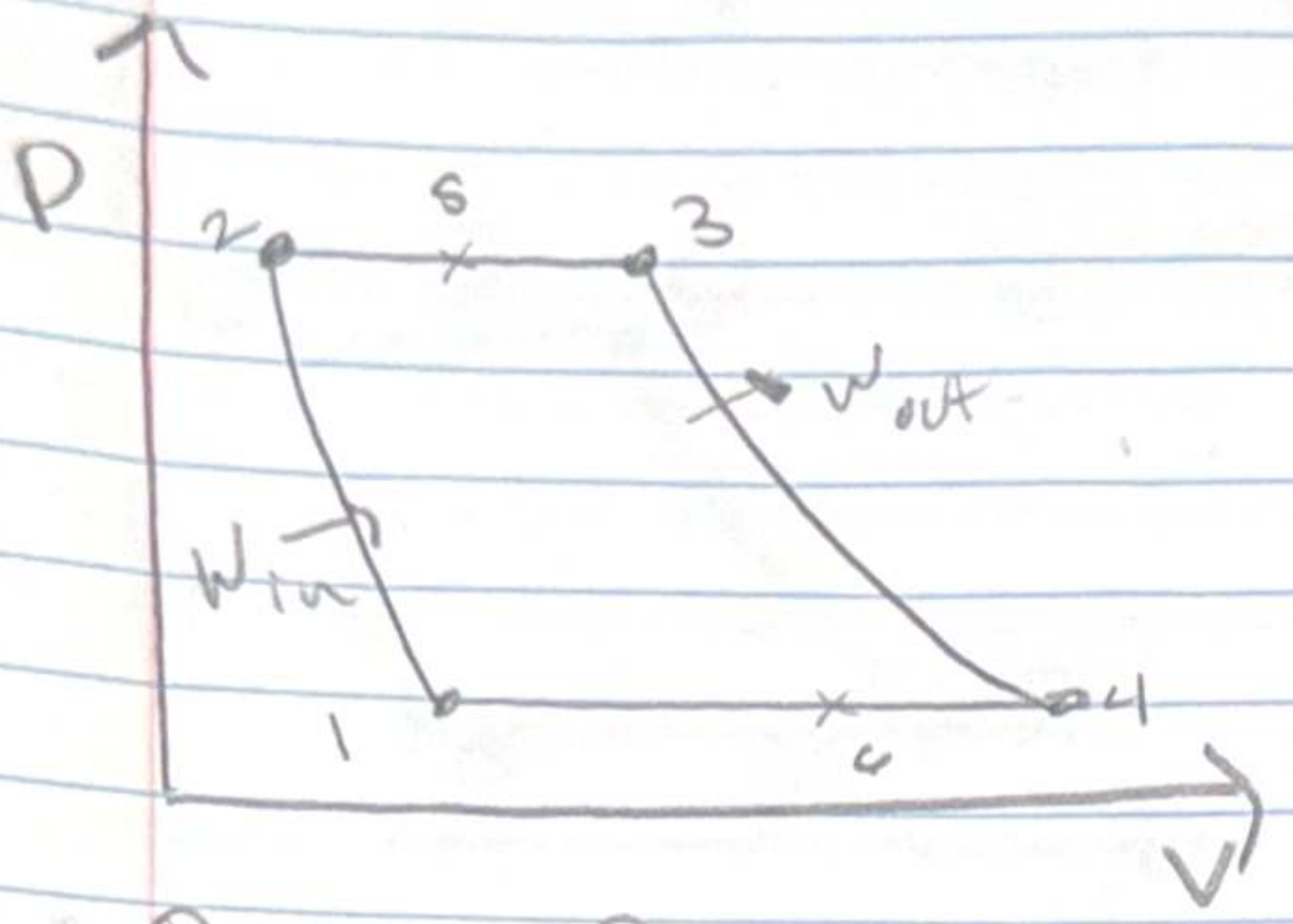
$\dot{m} = .486$

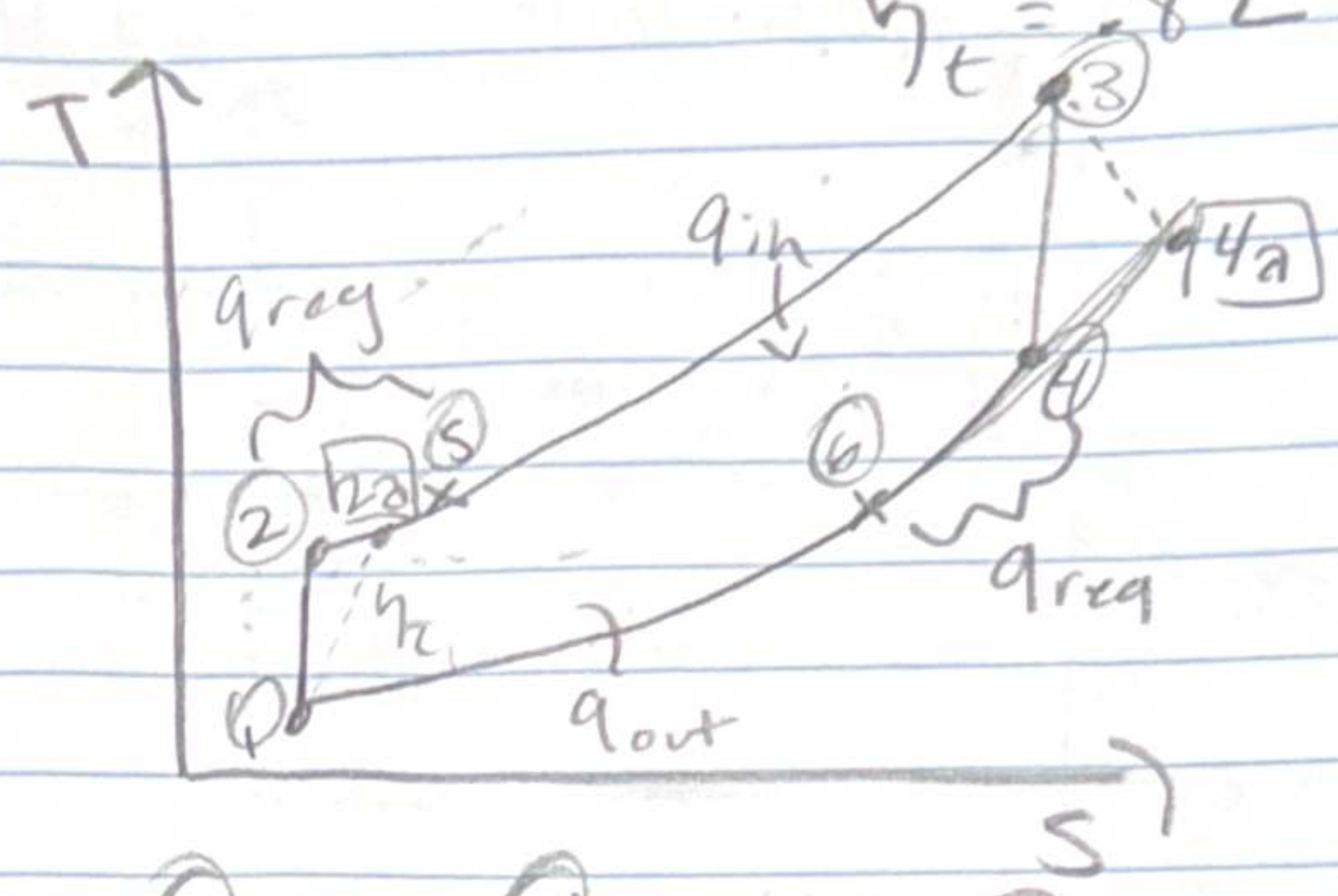
$q_{out} = C_p(T_6 - T_1)$
$= 1.005(594.9 - 303)$
$= 293.35$

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

$\dot{Q}_{in} = \dot{m} q_{in}$
$= (.486)(529.93)$
$= 257.54 kW$

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





1 → 2 (2a) → 5 → 3 → 4 (4A) → 6 → 1

$h_{4a} = 803.14$

using Table A-17 $T_1 = 310K$ $P_{r_1} = 1.554$ $h_1 = 310.24$	$P_2 = 7P_1$ $T_2 = 837$ $h_{2a} = 618.2$ $T_{2a} = 610.7$	$h_5 = 738.4$ $P_5 = P_2$ $T_5 = 723.3$	$h_3 = 1219.2$ $T_3 = 1150K$ $P_3 = P_2$ $P_{r_3} = 200.15$	$h_4 = 711.7$ $P_4 = P_1$ $T_4 = 698.6$ $P_{r_4} = 28.59$	$P_6 = P_1$ $T_6 = 671.71$ $h_6 = 682.97$ → A-17

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

$\frac{P_2}{P_1} = \frac{P_{r_2}}{P_{r_1}} \rightarrow P_{r_2} = 10.82 \xrightarrow{A-17} h_2$ $\frac{P_4}{P_3} = \frac{P_{r_4}}{P_{r_3}}$

$T_5 = 702.16K$ $P_{r_3} \rightarrow A-17$

A) $T_{Turb\,out} = T_{4a} = 747.82K$ A-17 $P_{r_4} = 28.593$

$T_4 = 698.63K$ A-17

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

C) $\eta_{th} = \frac{W_{net}}{q_{in}}$, $q_{in} = C_p(T_3 - T_5)$ $h_3 \rightarrow$ A-17

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

$\eta_c = \frac{h_2 - h_1}{h_{2a} - h_1} \rightarrow h_{2a}$ $\epsilon = \frac{h_5 - h_{2a}}{h_{4a} - h_{2a}}$ A-17 $T_5 = 723.3$

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

9-107 cont'd

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

$W_{out} = h_3 - h_{4a} = 416.10$

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

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

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

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

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

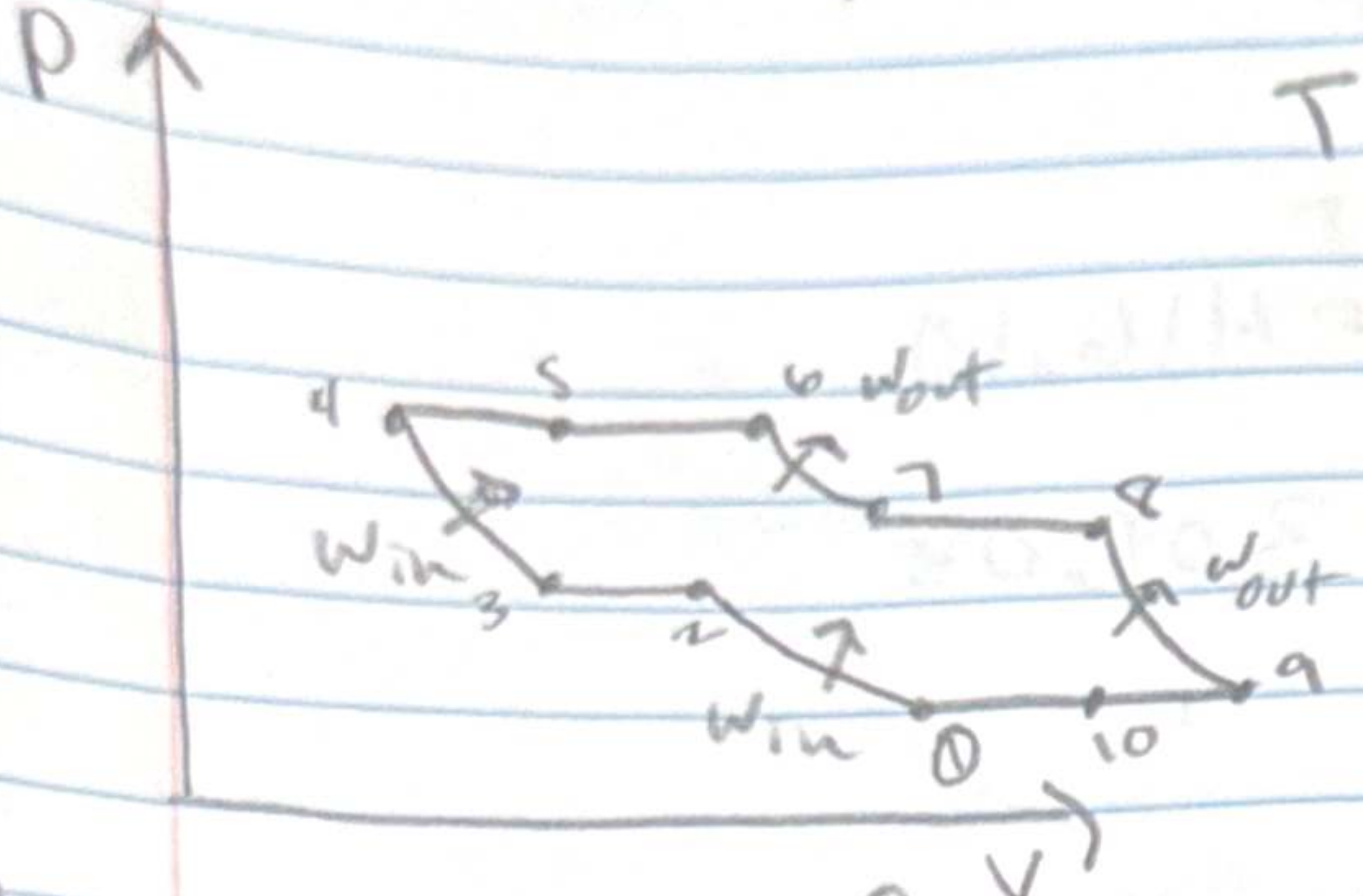
$\boxed{= 0.225}$

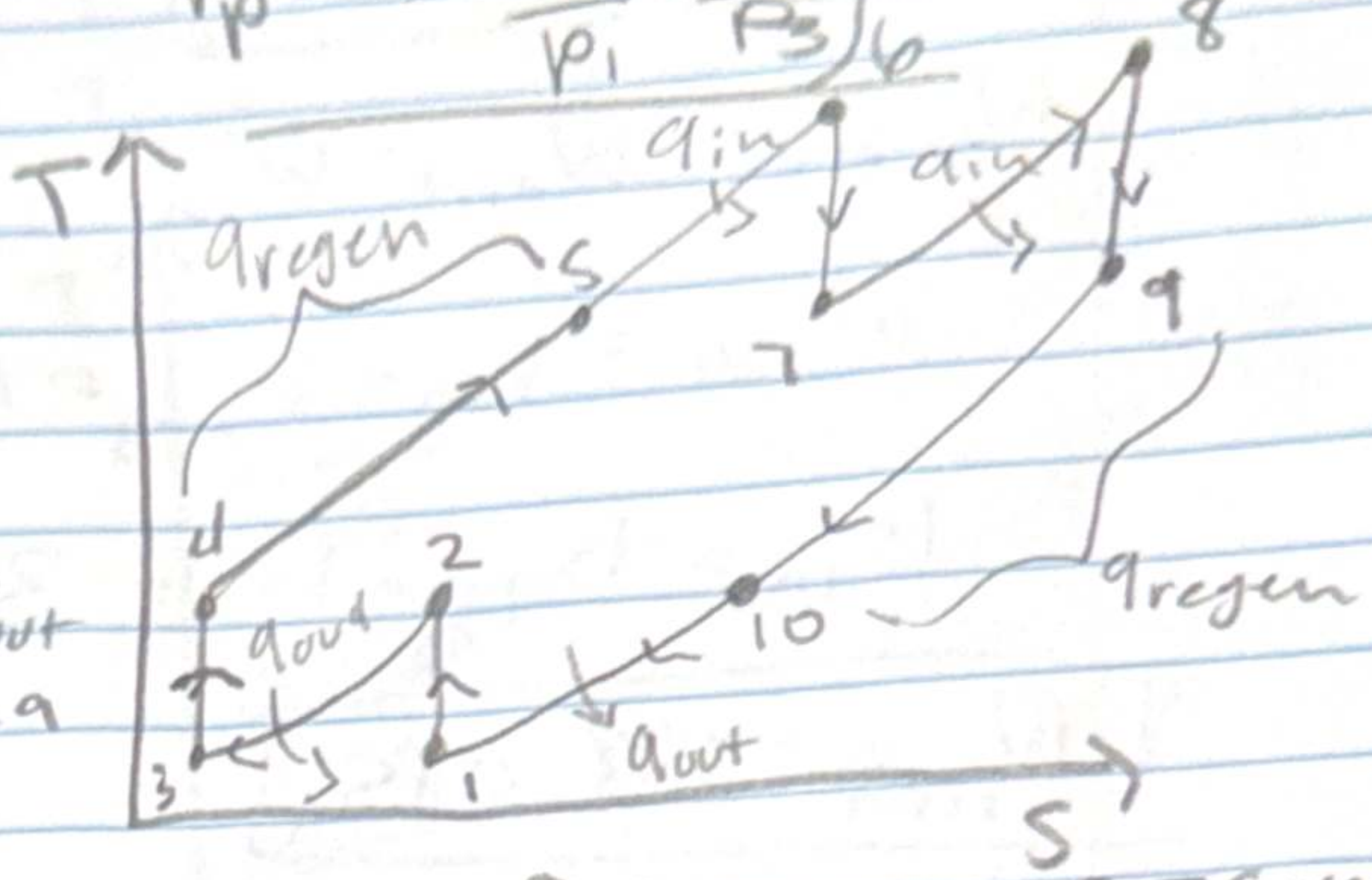
From A-17
h=300.19
$P_r = 1.38$

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

9-119 | $r_p = 9$

$r_p = 4 = \frac{P_2}{P_1} = \frac{P_4}{P_3}$





1 Isen 2 Pconst 3 Isent 4 Pconst regen 5 Pconst q_{in} 6 Isent

$T_1 = 300K$ $P_2 = 9P_1$ $T_3 = 300K$ $T_6 = 1200K$
$P_{r_1} = 1.38$

$P_2 = P_3$ $P_4 = P_5 = P_6$

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

$T_4 = T_2 = T_{10}$

$T_5 = T_7 = T_9$

6 Isentropic 7 Pconst q_{in} 8 Isent 9 Pconst regen 10 Pconst

$T_8 = 1200K$

$P_7 = P_8$ $P_9 = P_{10} = P_1$

★ Confusion on Solving for Some Stages ★