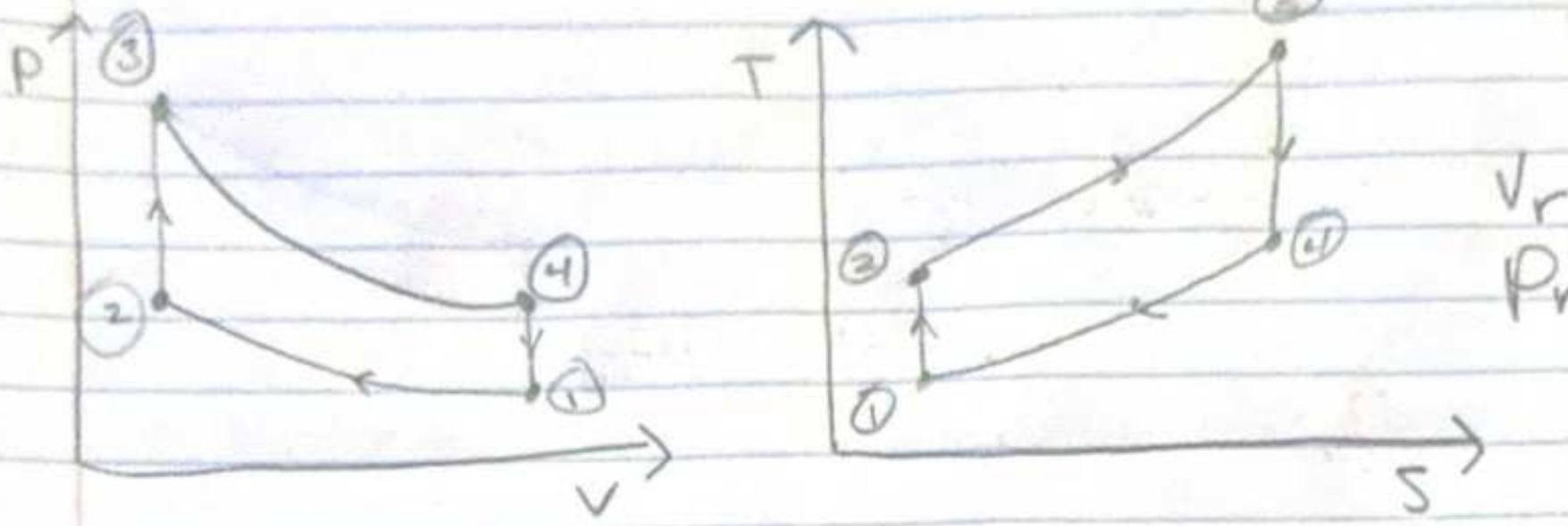
$P_4 = \frac{RT_4}{V_4} \rightarrow \frac{(.287)(754.3)}{(.906)}$

$P_4 = 238.94$

HW 1.3 — Mizell Smalls

9-33 $h = 300.19$

$r = 8 \quad R = .287 \quad C_p = 1.005 \quad C_v = 0.718$



$k = 1.4$

$V_r = 621.2$

$P_r = 1.386$

$U = 214.07$

$q_{in}_{2-3} = 750$

1 → Isentropic → 2 → V constant → 3 → Isentropic → 4 → V constant → 1

$27°C + 273 =$

$T_1 = 300K$	$T_2 = 689.82$	$T_3 = 1733$	$T_4 = 754.3$
$P_1 = 95kPa$	$P_2 = 752.02$	$P_3 = 4401.5$	$P_4 = 238.94$
$V_1 = .906$	$V_2 = .113$	$V_3 = .113$	$V_4 = .906$

$PV = RT$

$V_1 = \frac{RT_1}{P_1} \quad \frac{(.287)(300K)}{95kPa}$

$V_1 = .906$

$V_2 = V_1/8$

$= .906/8$

$= .113$

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

$T_4 = 1733\left(\frac{1}{8}\right)^{.4}$

$P_2 = \frac{RT_2}{V_2} = \frac{(.287)(689.82)}{.113}$

$P_2 = 1752$

$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{k-1}$

$T_2 = \left(\frac{V_1}{V_2}\right)^{k-1} \cdot T_1$

$= \left(\frac{.906}{.113}\right)^{.4}(300)$

$T_2 = 689.82$

$P_3 = \frac{RT_3}{V_3} = \frac{(.287)(1733)}{.113}$

$P_3 = 4401.5$

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

$T_3 = (689.82) + \frac{750}{.718}$

$T_3 = 1733$

1.3)

Mizell
Smalls

= 0.718

k = 1.4

$V_r = 621.2$
$P_r = 1.386$

U = 2H.07
$q_{in} = 750$
2-3

-1)

1 = 754.3
4 = 238.94
4 = .906

I3
V3
= (750)(1783) / .113
P2 = 4401.5

lin
V
) + 750 / .718
3

A-33 Cont'd

A) T3 = 1733K
P3 = 4401.5 kPa

B) $q_{in} = 750$

$q_{out} = C_v(T_4 - T_1)$

$= .718(794 - 300)$

$q_{out} = 325.972$

$W_{net} = 750 - 329.9$
$= 424.1$

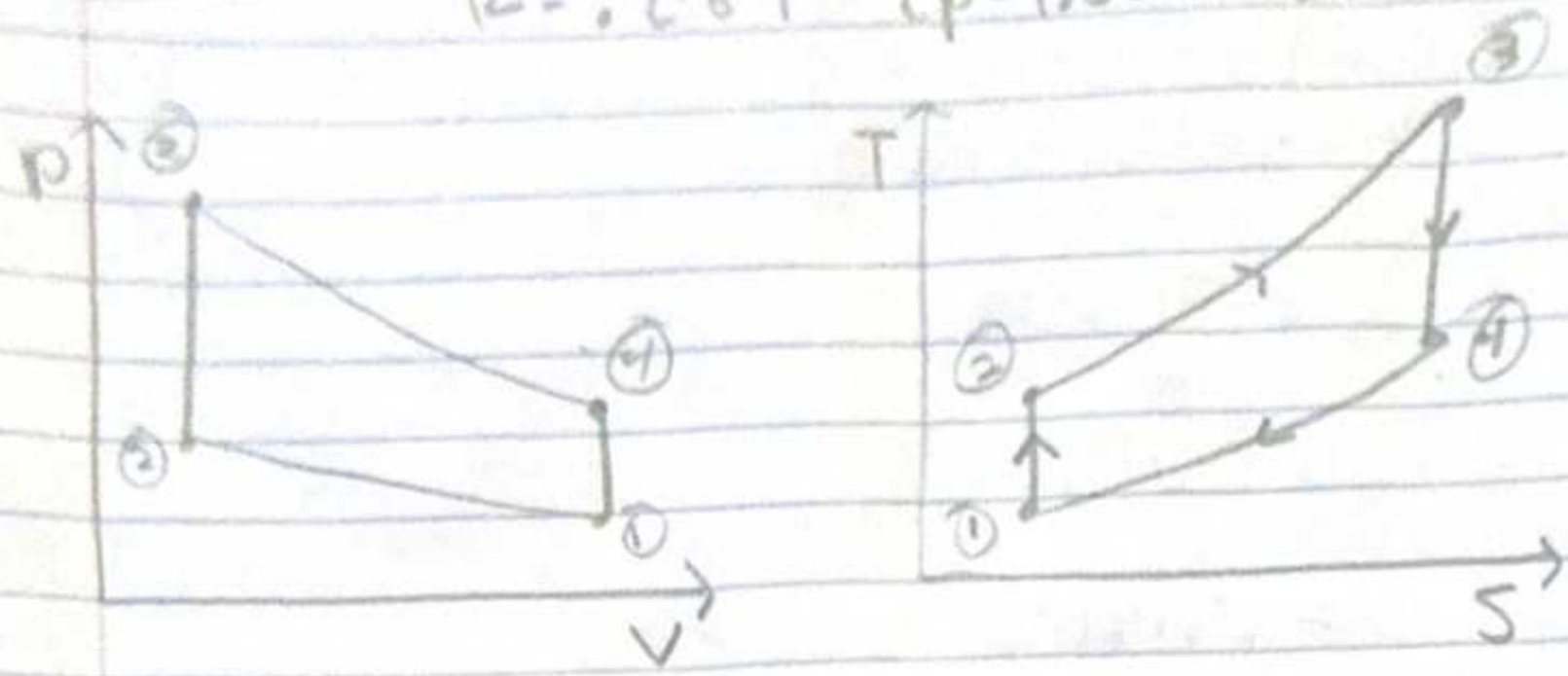
C) $\eta_{th} = \frac{W_{net}}{q_{in}}$

$= \frac{424.1}{750} \rightarrow .565$ 56.5%

D) $\frac{W_{net}}{V_1 - V_2}$ = mean effective pressure

$\frac{424.1}{.906 - .113} \rightarrow$ 534.8 kPA

9-36 | R=.287 Cp=1.005 Cv=0.717 k=1.4



1 Isentropic 2 V constant 3 Isentropic 4 V constant

T1=313.71K T2= T3=1588.71K T4=
P1=96.53 P2= P3= P4=
V1=0.932 V2= V3= V4=0.932

$T_K = \frac{(105-32)\times 5}{9} + 273.15$

$T_{K1} = 40.56 + 273.15$

$T_{K1} = 313.71K$

$T_{K3} = \frac{(2400-32)\times 5}{9} + 273.15$

$T_{K3} = 1588.71K$

1psia = 6.894kPa

$P_{kPa} = 14 \times 6.894$

$= 96.53$

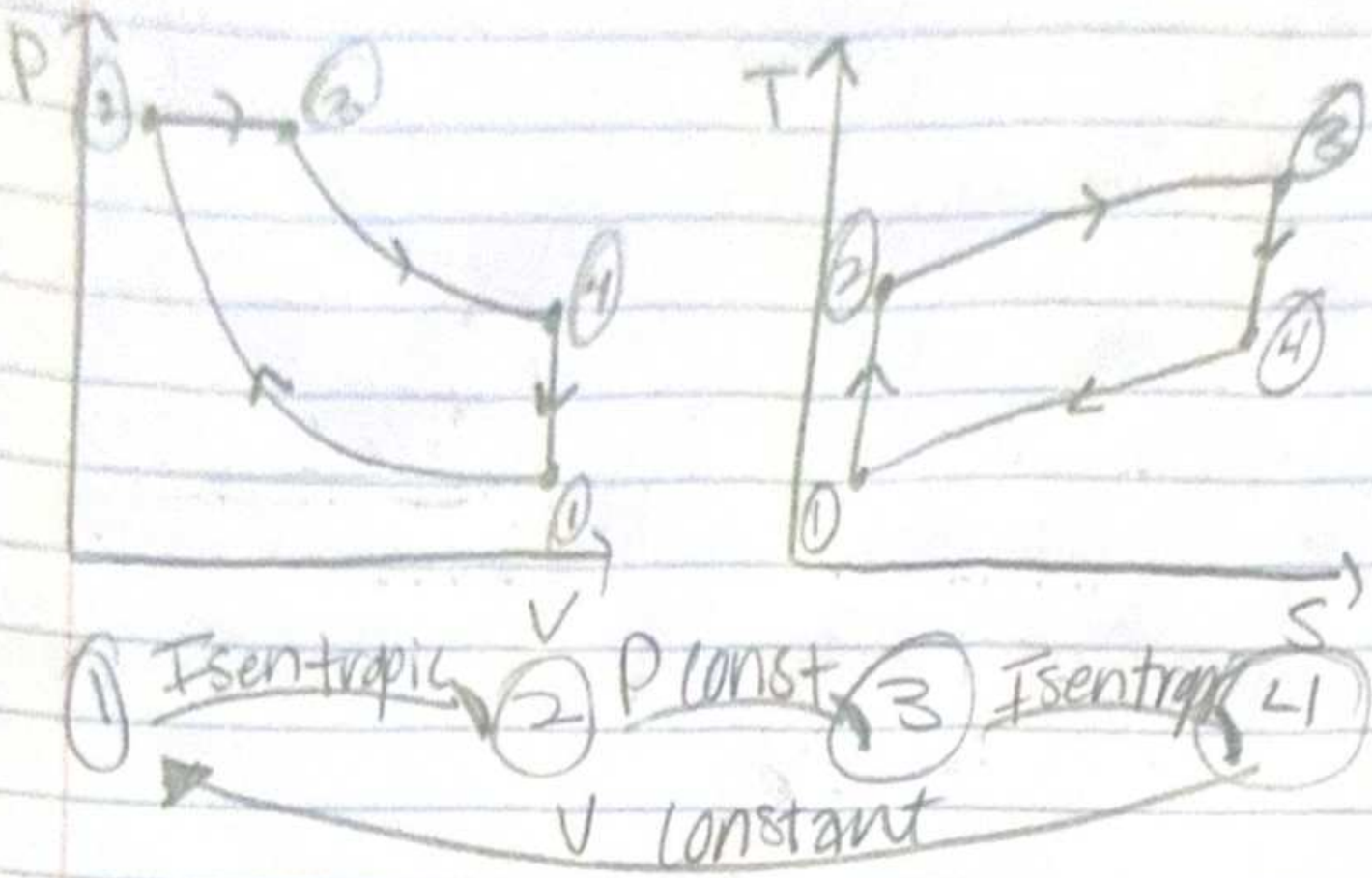
$PV = RT$

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

$V_1 = \frac{(.287)(313.71)}{(96.53)}$

9-96 |

r = 16 r_c = 2 R = .287 C_p = 1.005 C_v = .718



k = 1.4

V_r = 621.2

P_r = 1.386

U = 214.07

T1 = 300K T2 = 913.47 T3 = 1826.9 T4 = 791.6

p1 = 95kpa p2 = 4681.5 p3 = 4681.5 p4 = 250.7

V1 = .906 V2 = 0.056 V3 = .112 V4 = .906

27°C + 273

T_1 = 300K

$V_1 = \frac{RT_1}{P_1} \quad \frac{(.287)(300)}{95}$

$V_2 = V_1/16$

$V_2 = .906/16$

$T_2 = \left(\frac{V_1}{V_2}\right)^{k-1} T_1$

$T_2 = \left(\frac{.906}{.056}\right)^{1.4-1} \cdot T_1$

$= 16.17^{.4} \cdot 300$

$T_2 = 913.47$

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

$P_2 = \frac{(.287)(913.47)}{0.056}$

$r_c = \frac{V_3}{V_2}$

$2 = \frac{V_3}{.056}$

$V_3 = (2)(.056)$

$\frac{P_3 V_3}{R} = T_3$

$\frac{(4681.5)(.112)}{(.287)} = T_3$

$T_4 = T_3 \left(\frac{V_3}{V_4}\right)^{k-1}$

$= 1826 \left(\frac{.112}{.906}\right)^{.4}$

$P_4 = \frac{RT_4}{V_4}$

$\frac{(.287)(791.6)}{.906}$

$P_4 = 250.7$

me
ffect
pressu

=1.005 Cv=.718

k=1.4

V_r=621.2
P_r=1.386

U=214.07

9 T4=791.6
.5 P4=250.7
V4=.906

$P4 = \frac{RT_4}{V_4}$

$\frac{(.287)(791.6)}{.906}$

P4=250.7

T3

112)=T3

9-40 cont'd

A) $T_3 = 1826.9K$

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

$\eta_{th} = 1 - \frac{T_4 - T_1}{k(T_3 - T_2)} = 1 - \left(\frac{791.6 - 300}{k(1826.9 - 913.47)}\right)$

$= 1 - \frac{491.6}{1278.8}$

$= 1 - 0.384$

$\eta_{th} = .616$

$= 61.6\%$

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

$= 1.005(1826.9 - 913.47)$

$q_{in} = 917.99$

$q_{out} = C_v(T_4 - T_1)$

$= .718(791.6 - 300)$

$q_{out} = 352.96$

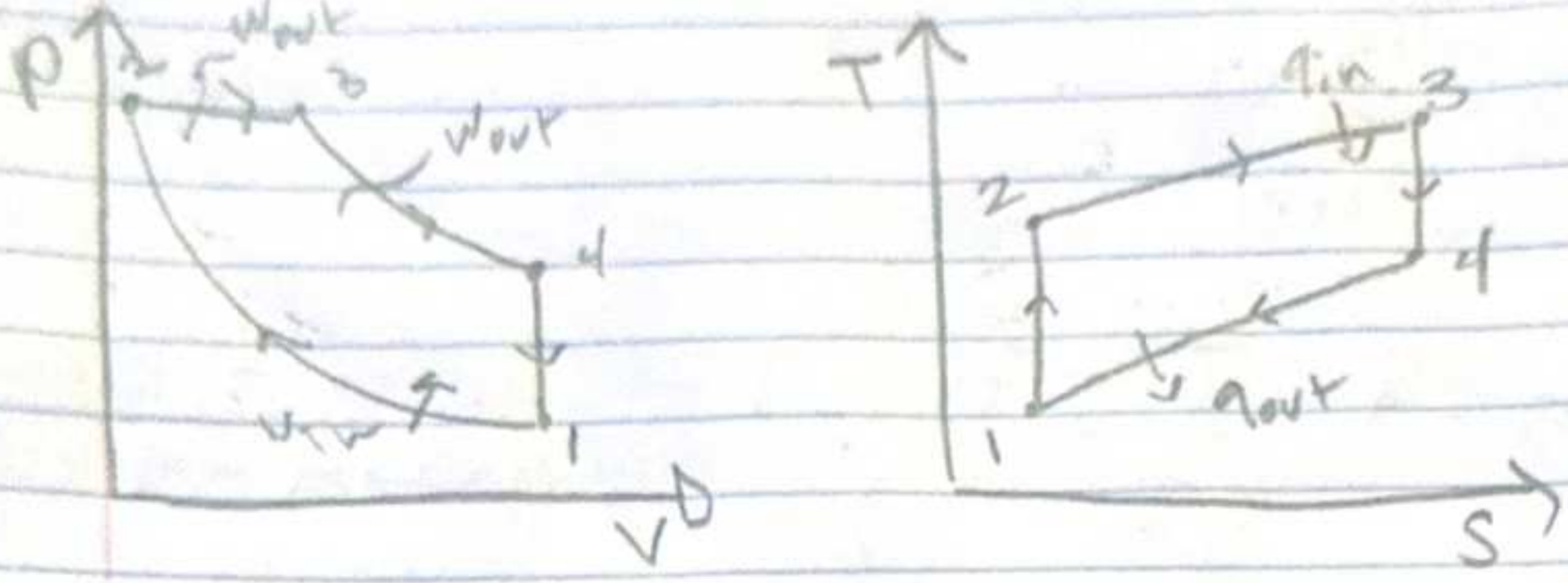
$W_{net} = 917.99 - 352.96$
$= 565.03$

mean effect. pressure $= \frac{W_{net}}{v_1 - v_2} \rightarrow \frac{565.03}{.906 - .056} = 664.74 \text{ kPa}$

9-57] R=.287 2HL 4cyl

r = 22 r_c = 1.8 K=1.4 Cp=1.005 Cv=.718

3500rpm



① Isent ② P const ③ Isent ④

V constant

T1 = 343K T2 = 1181.9 T3 = 2127.4 T4 = 780.9

P1 = 97kPa P2 = 7374.02 P3 = 7374.02 P4 = 221.02

70°C V1 = 1.014 V2 = 0.046 V3 = 0.0828 V4 = 1.014

+273

343K $V_1 = \frac{RT_1}{P_1}$ $V_2 = V_1 \left(\frac{22}{1}\right)$ $r_c = \frac{V_3}{V_2}$ $P_4 = \frac{RT_4}{V_4}$

$= \frac{(.287)(343)}{97}$ $T_2 = \left(\frac{V_1}{V_2}\right)^{k-1} T_1$ $1.8 = \frac{V_3}{0.046}$

$V_1 = 1.014$ $= \left(\frac{1.014}{.046}\right)^{.4} .343$

$P_2 = \frac{RT_2}{V_2} \rightarrow \frac{(.287)(1181.9)}{0.046}$

$T_3 = \frac{P_3 V_3}{R}$

$T_3 = \frac{(7374.02)(0.0828)}{(.287)}$ $P_2 = 7374.02$

$T_4 = T_3 \left(\frac{V_3}{V_4}\right)^{k-1}$

$T_H = 2127.4 \left(\frac{0.0828}{1.014}\right)^{.4}$

9-57 cont'd

W_{out} $_{2-3} = P_2(V_3 - V_2) =$

$= 73741.02(0.0828 - 0.046)$

$= 271.36$

W_{out} $_{3-1} = \frac{R(T_4 - T_3)}{1-k}$

$= \frac{.287(780.9 - 2127.1)}{1 - 1.4}$

$= 963.96$

W_{in} $_{1-2} = \frac{R(T_1 - T_2)}{1-k}$

$= \frac{.287(343 - 1181.9)}{1 - 1.4}$

$= 601.91$

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

$= 271.36 + 963.96 - 601.91$

$W_{net} = 633.41 kJ/kg$

Total Displacement $V = 2.4$

↳ per cylinder $= 0.6L$

$r = \frac{V_c + V_d}{V_c} \rightarrow 22 = \frac{V_c + 0.0006m^3}{V_c}$

$V_c = 0.00002857$

$W_{net} = \frac{m}{120} W_{net\,in}$

$= \frac{.000619}{120} \cdot 633.41 \cdot 3600$

$= 11.42 kW$

$V_1 = V_c + V_d$

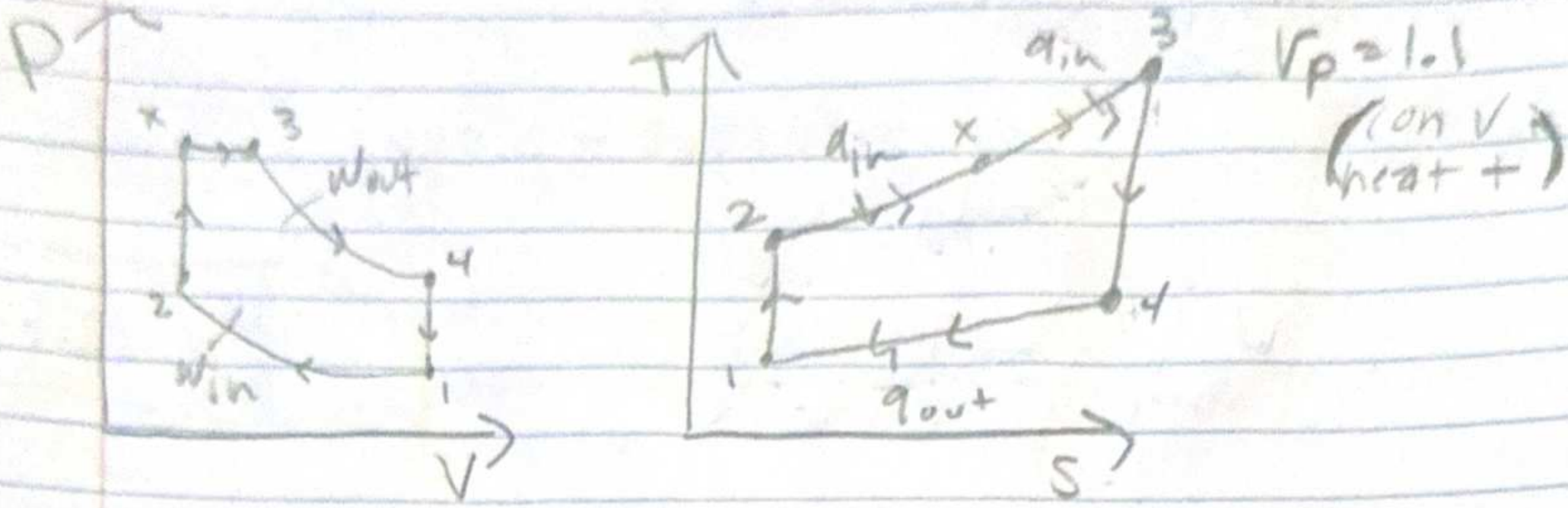
$= .00002857 + .0006$

$V_1 = 0.000628$

$m = \frac{V_1}{v_1} = \frac{0.000628}{1.014}$

$m = .000619$

9-89 | $r = 15$ $r_c = 1.4$ $R = .287$
$C_p = 1.005$ $C_v = .718$ $k = 1.4$



1 isentrop → 2 V const → x p const → 3 isentropic
V constant → 1

$P_1 = 97.9 kPa$	$P_2 = 434.21$	$P_x = 477.631$	$P_3 = 477.631$	$P_4 = 172.6$
$T_1 = 297.039 K$	$T_2 = 577.5$	$T_x = 965.2$	$T_3 = 1361.3$	$T_4 = 523.3$
$V_1 = .87$	$V_2 = .068$	$V_x = .058$	$V_3 = .0812$	$V_4 = .87$

1 psia = 6.89 kPa

14.2 psia • 6.89 kPa

75°F

$\frac{(75-32) \cdot 5}{9} + 273$

$V_2 = \frac{V_1}{r}$

$T_2 = \left(\frac{V_1}{V_2}\right)^{k-1} \cdot T_1$

$V_x = \frac{V_3}{r_c}$ $V_4 = V_1$

$P_x = r_p P_2$

$P_2 = \frac{R T_2}{V_2}$ $T_x = \frac{P_x V_x}{R}$

$V_1 = \frac{R T_1}{P_1}$

$V_x = V_2$

$T_3 = \frac{P_3 V_3}{R}$

$\frac{T_4}{T_3} = \left(\frac{V_3}{V_4}\right)^{k-1}$

$T_4 = T_3 \left(\frac{V_3}{V_4}\right)^{k-1}$ $P_4 = \frac{R T_4}{V_4}$

9-89 cont'd

$q_{in_A} = C_v(T_x - T_2)$

$= .718(965.2 - 877.5)$

$q_{in_A} = 62.96$

$q_{in_B} = C_p(T_3 - T_x)$

$= 1.005(1381.3 - 968.2)$

$= 1.005(386.1)$

$q_{in_B} = 388.03$

$q_{in} = 62.96 + 388.031$

$\boxed{q_{in} = 450.99}$

$q_{out} = C_v(T_4 - T_3)$

$= .714(823.3 - 1351.3)$

$= -594.5$

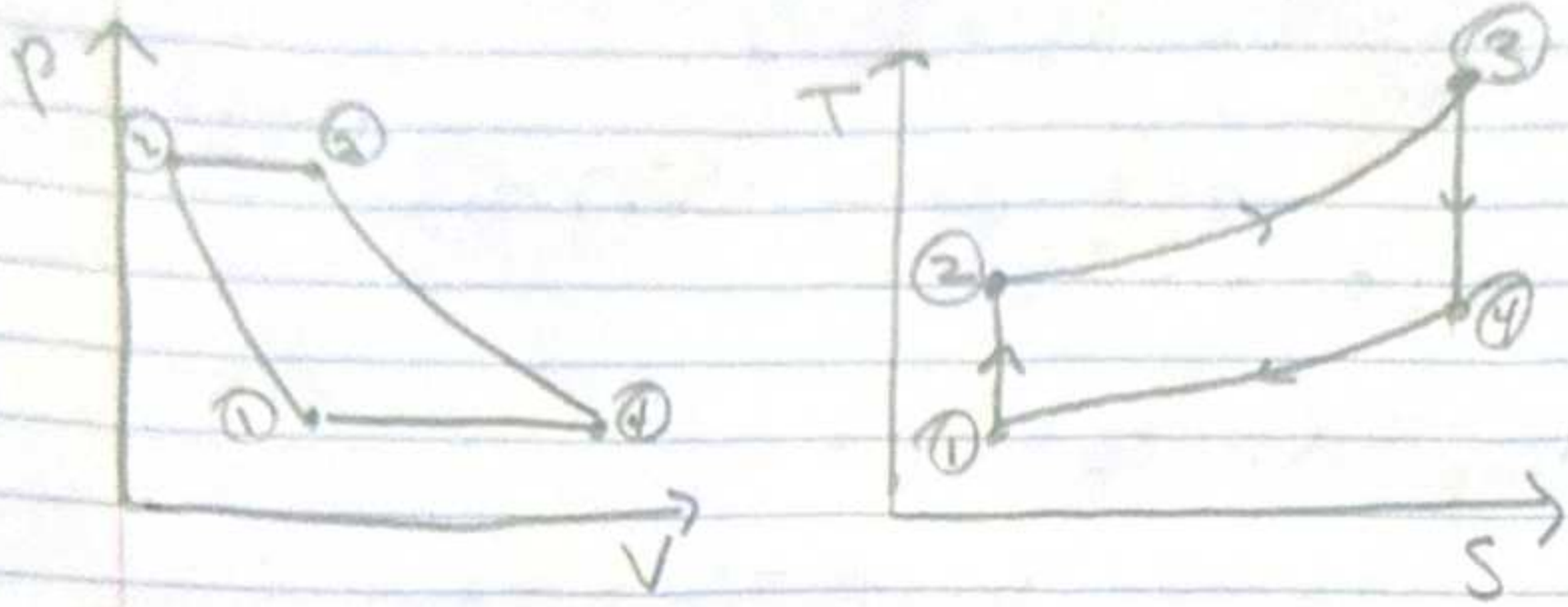
$W_{net} = q_{in} - q_{out}$

$= 450.99 - (-594.5)$

$\boxed{W_{net} = 1045.49}$

$\eta_{th} = \frac{W_{net}}{q_{in}} \rightarrow \frac{1045.49}{450.99} \rightarrow 2.318$

9-80 | $r_p = 10$



1 Isent → 2 p const → 3 Isent → 4 p const → 1

$T_1 = 520R$ $T_2 = 996.4R$ $T_3 = 2000R$ $p_4 = p_3/10$

$p_2 = 10p_1$ $p_4 = p_1$

Table A-17 $P_{r_3} = 174.0$ $T_4 = 1049.31R$

$P_{r_1} = 1.214$

$P_{r_4} = \left(\frac{p_4}{p_3}\right) P_{r_3}$ $h_4 = 265.83$

$\frac{p_2}{p_1} = \frac{P_{r_2}}{P_{r_1}} \rightarrow P_{r_2} = \left(\frac{p_2}{p_1}\right) P_{r_1}$

$P_{r_4} = 17.40 \rightarrow T_4$

$P_{r_2} = 12.147$

A) Table A-17

$\boxed{T_2 = 996.4}$

$h_1 = 124.27$ $h_2 = 240.11$ $h_3 = 504.71$

B) $\frac{W_{comp}}{W_{exp}} = \frac{W_{in_{1-2}}}{W_{out_{3-4}}}$ $W_{in_{1-2}} = h_2 - h_1 = 115.84$

$\frac{115.84}{239.88} = \boxed{0.485}$ $W_{out_{3-4}} = h_3 - h_4 = 238.88$

C)

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

$= \frac{W_{out} - W_{in}}{q_{in}}$

$\boxed{= 0.465}$