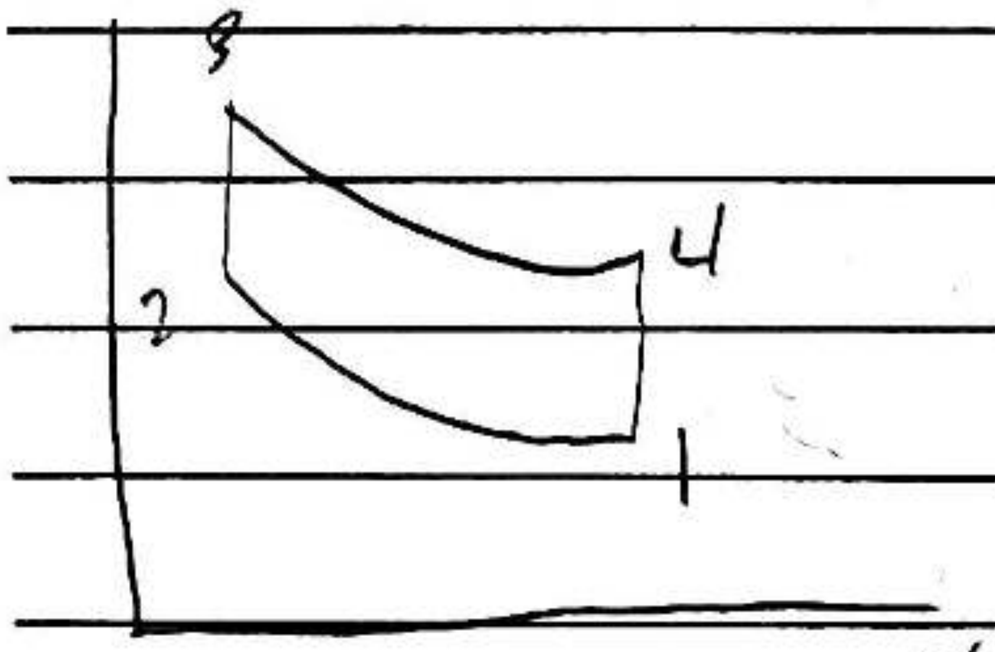
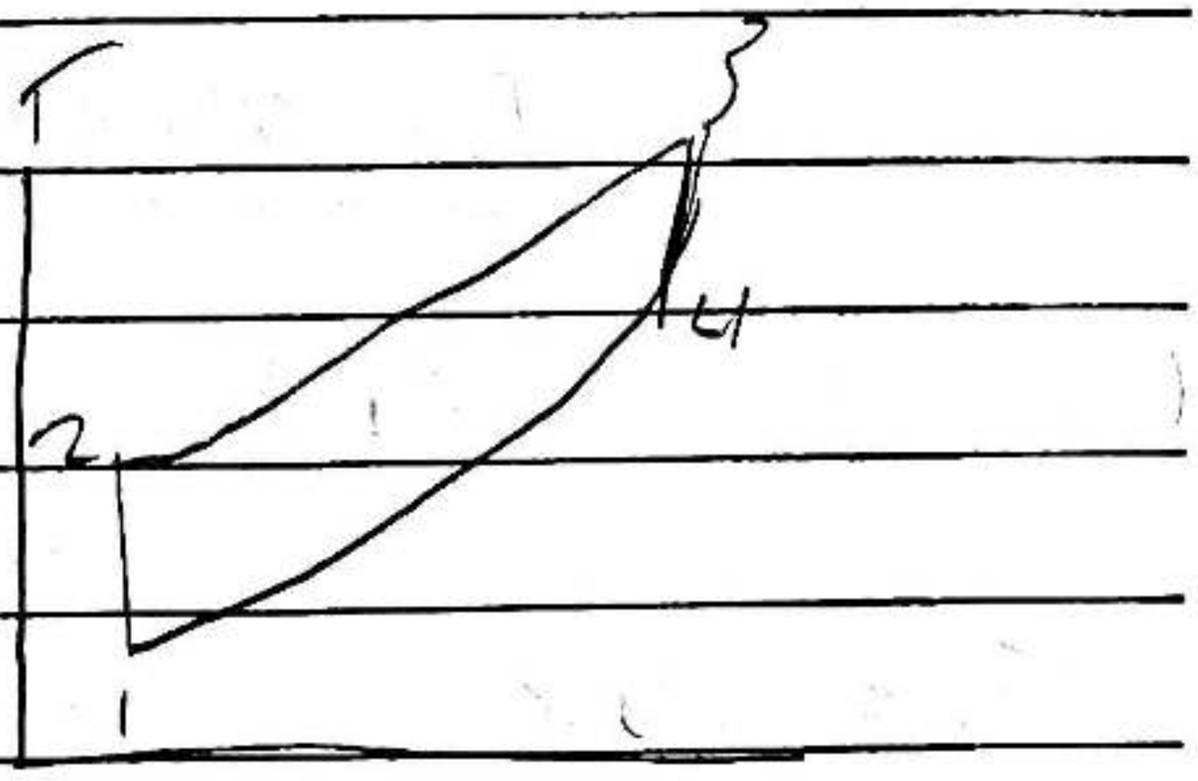
ROYSHEARD HW 1,3 Ch 9

33, 36, 46, 57, 59, 80

33)





P-V

T-S

$P_1 = 8$ kPa $P_2 = 95$ kPa

$T_1 = 27°C = 300.15K$

$q_{IN} = 750$ KJ/KG

Air T_1

$U_1 = 214.07$ kJ/kg $U_{r_1} = 621.2$

$U_{r_2} = \frac{U_{r1}}{r} = \frac{621.2}{8} = 77.65 \simeq 78.61$

$T_2 = 670K$ $U_2 = 488.81$ kJ/kg

$P_2 = P_1 r \frac{T_2}{T_1} = 95.8 \cdot \frac{670}{300} = 1697.3$ kPa

$\Delta U_2 - 3 = q_{IN} = U_3 - U_2 = q_{IN}$

$U_3 = U_2 + q_{IN} = 1238.81 \simeq 1242.43$

$T_3 = 1540K$ $V_3 = 6.569$

$P_3 = P_2 \frac{T_3}{T_2} = 1697.3 \cdot \frac{1540}{620} = 3501 kPa$

$\boxed{T_3 = 1540 K}$ $\boxed{P_3 = 3501 kPa}$

(b) $U_{14} \cdot r \cdot U_{r_3} = 8 \cdot 6.569$

$= 52.6 \simeq 51.44$

$T_4 = 780 K$ $U_4 = 576.12$

$W = q_{in} - q_{out} = q_{in} - (U_4 - U_1)$

$= (750 - (576.12 - 214.07)) = \boxed{387,9 \frac{kJ}{kg}}$

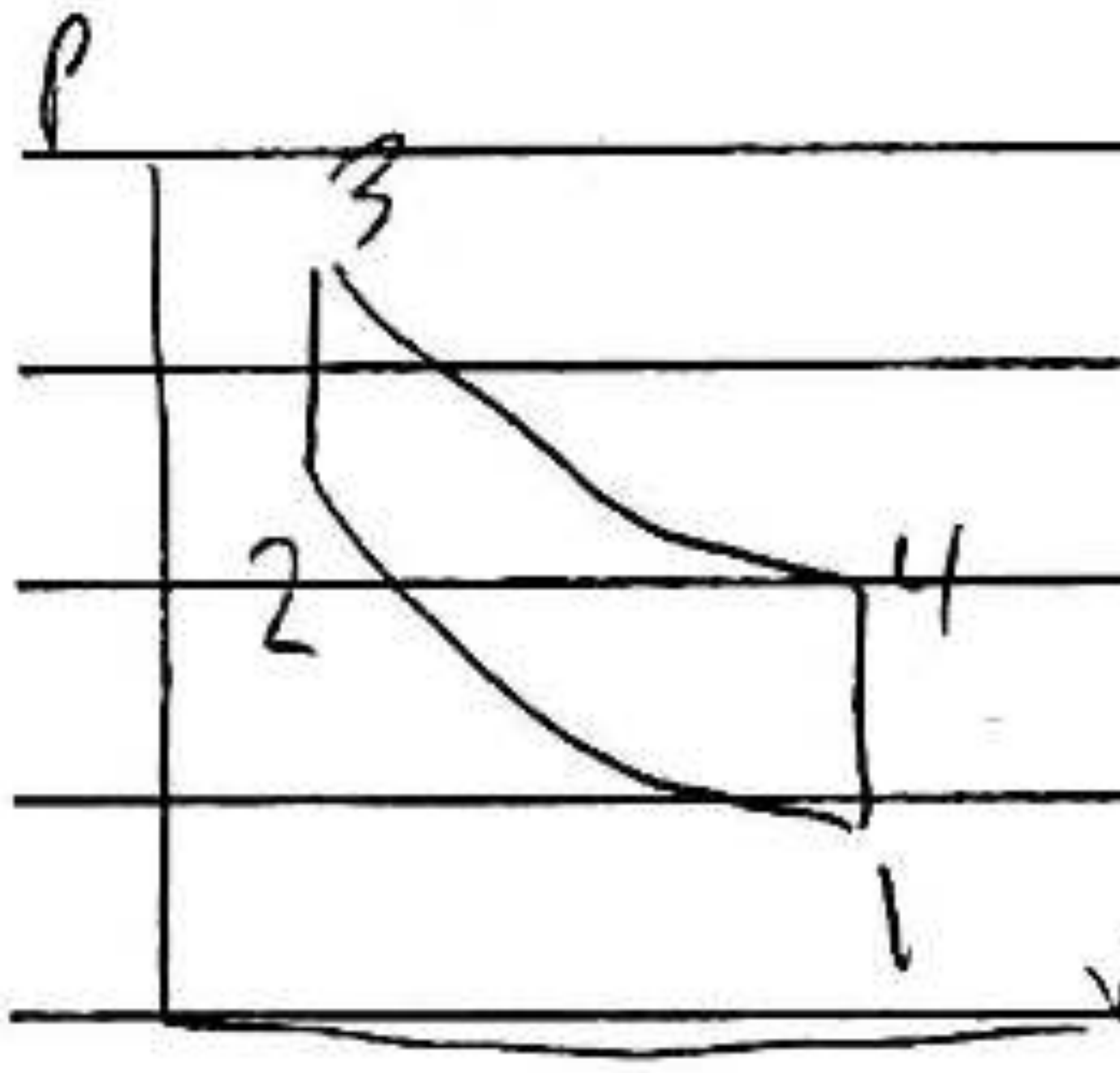
(c) $n = \frac{w}{q_{in}} = \frac{387,9}{750} = \boxed{0.51}$

(d) $MEP = \frac{W}{U_1 - U_2} = \frac{W}{U_1(1-1/r)} =$

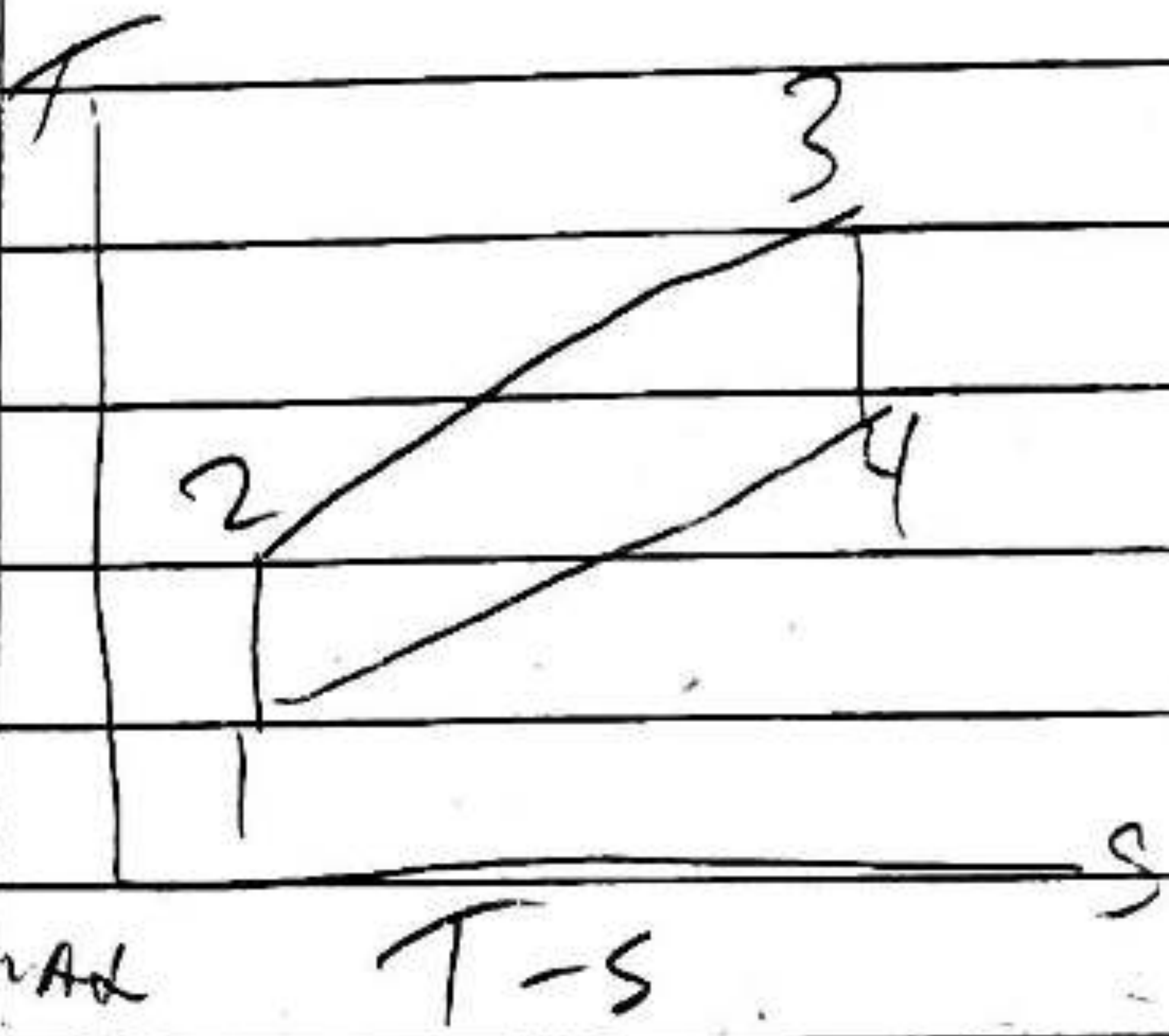
$\frac{r w P_1}{R T_1 (r-1)} = \frac{8 \cdot 387,9 \cdot 95}{0,287 \cdot 300 (8-1)}$

$= \boxed{469,1 kPa}$

36)



6cyl
14 PSIA
105°F
MAX 2400°F
bore 3.5in
Stroke 3.9in
V 9.8% of MAX



$$T_2 = T_1 r^{k-1} = 565 \cdot \left(\frac{1}{0.098}\right)^{1.4-1} R$$

$$= 1430.5 R$$

$$T_4 = T_3 r^{1-k} = 2860 \cdot 10.2^{1-1.4} R$$

$$= 1129.6 R$$

$$m = \frac{NV}{v_1} = \frac{P_1 N \pi B^2 S}{4 R T_1} = \frac{14.6 \cdot \pi \cdot 3.5^2 \cdot 3.9 \left(\frac{1}{12}\right)^3}{4 \cdot 0.3704 \cdot 565} lbm$$

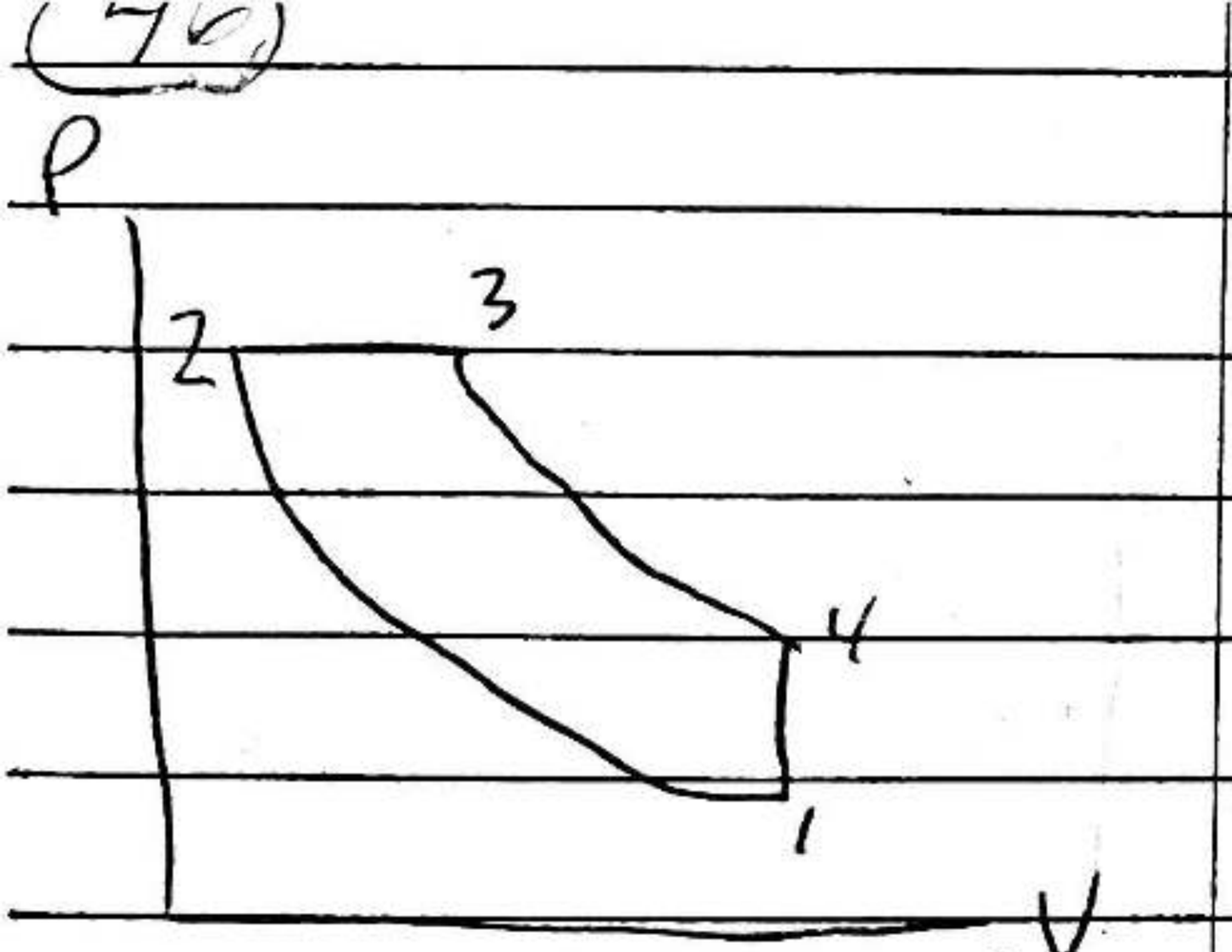
$$= 8.72 \cdot 10^{-3} lbm$$

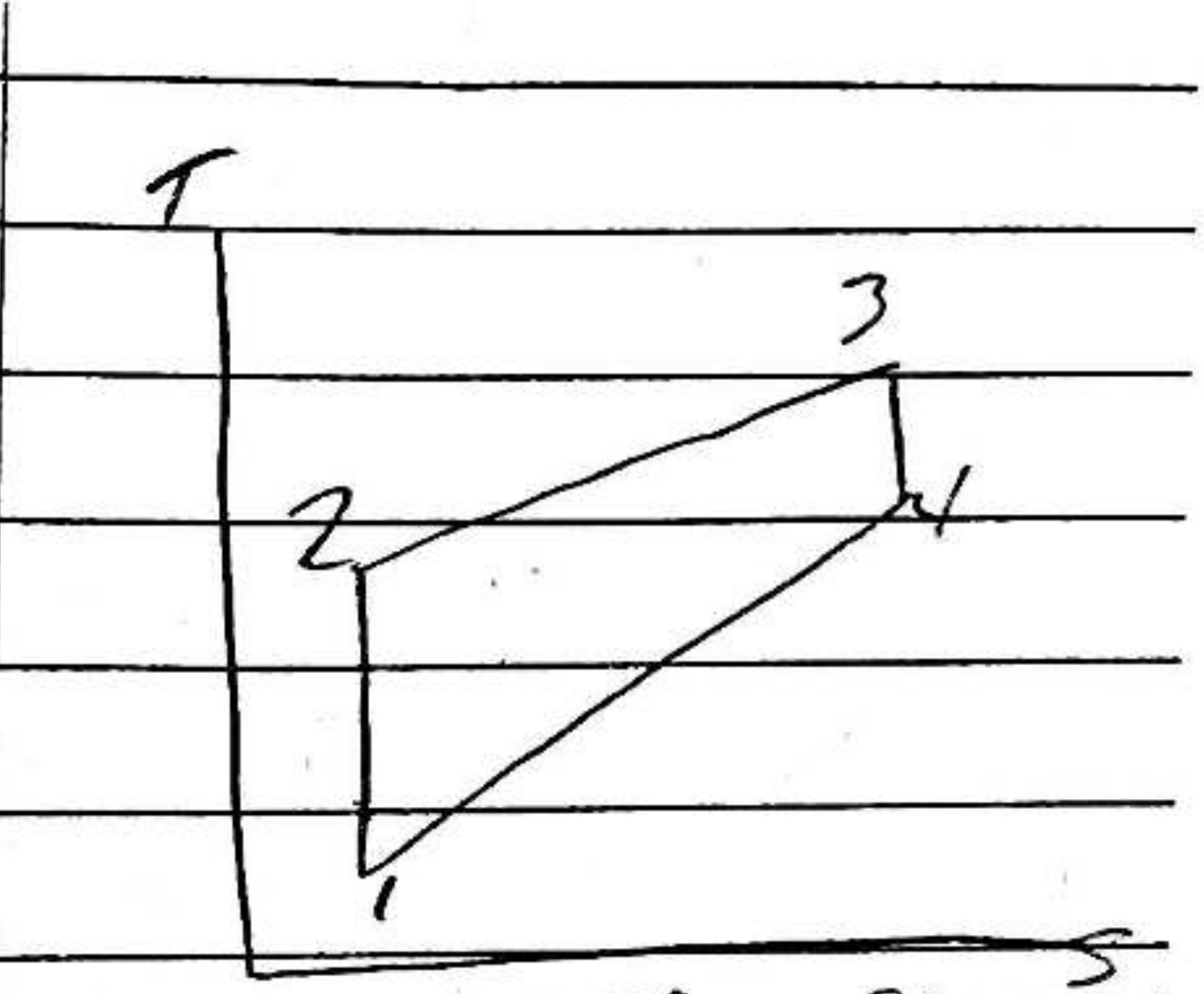
$$W = \frac{n}{N_{cv}} m w = m n c_v \left(T_3 - T_4 - (T_2 - T_1)\right)$$

$$\frac{8.72 \cdot 10^{-3} \cdot 2500 \cdot 0.171}{60 \cdot 2 \cdot 0.7068} \left(2860 - 1129.6 - (1430.5 - 565)\right)$$

$$= \boxed{38 hp}$$

(76)





$r = 16 \quad r_c = 2 \quad P_1 = 95 kPa \quad T_1 = 27°C = 300.15K$

$U_1 = 214.07 kJ/kg \quad U_{r1} = 621.2$

$U_{r2} = \frac{U_{r1}}{r} = \frac{621.2}{16} = 38.83 \simeq 39.12$

$h_2 = 888.3 \quad T_2 = 860K$

$T_3 = T_2 \cdot 2 = 860 \cdot 2 = \boxed{1720K} \simeq 1750K$

$h_3 = 1941.6 \quad U_{R3} = 4.33$

$U_{r4} = \frac{r}{r_c} U_3 = \frac{16}{2} \cdot 4.33 = 34.64$

$U_4 = 657.95 \frac{kJ}{kg}$

$\eta = 1 - q_{out}/q_{in} = 1 - \frac{U_4 - U_1}{h_3 - h_2} = 1 - \frac{657.95 - 214.07}{1941.6 - 888.3}$

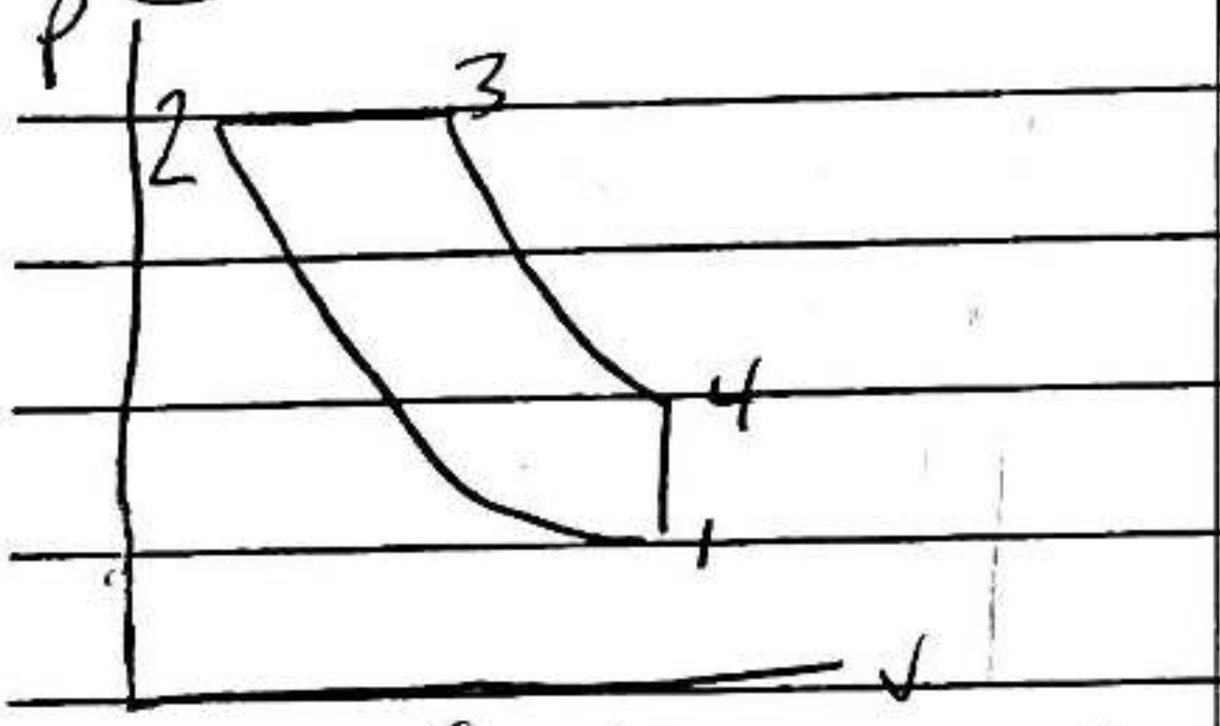
$= \boxed{0.58}$

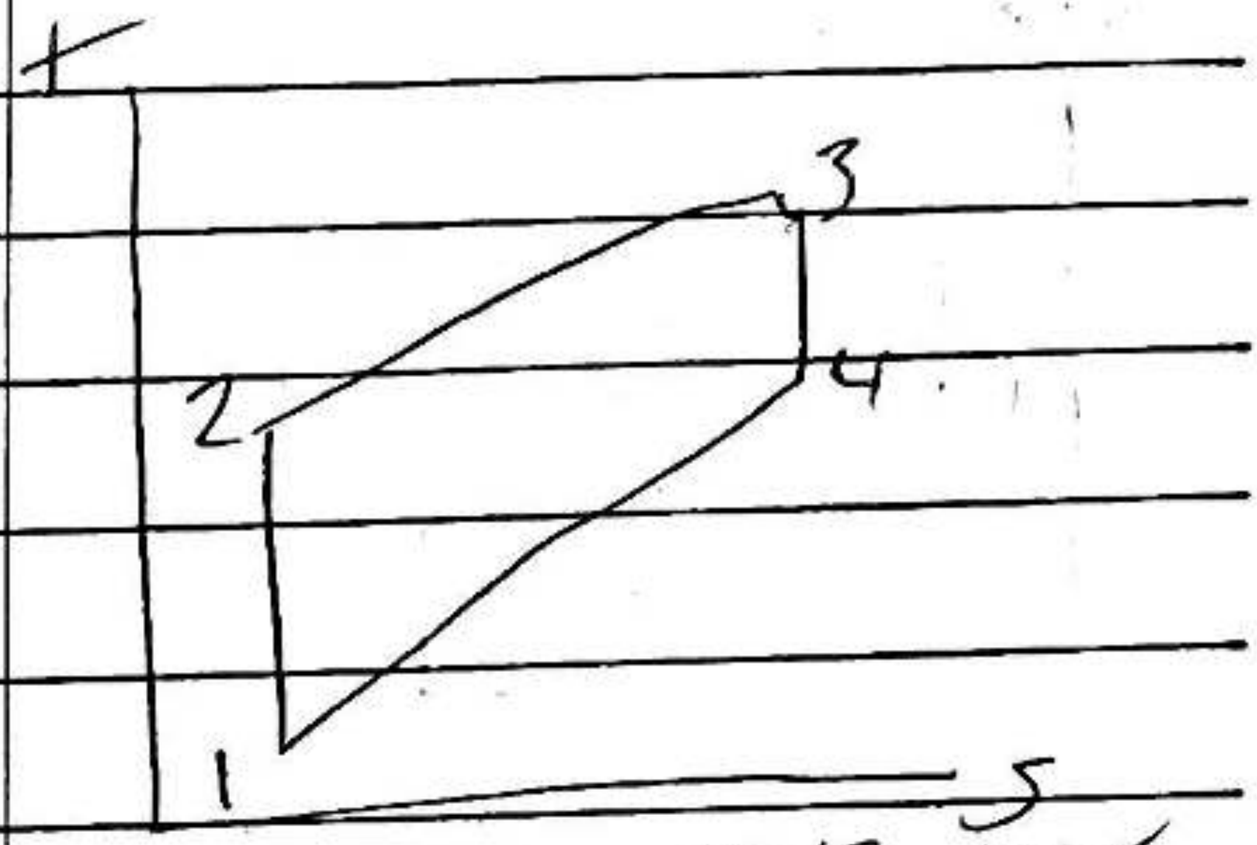
$MEP = \frac{w}{V_1(1 - \frac{1}{r})}$

$\frac{\eta(h_3 - h_2)}{\frac{RT_1}{P_1}\left(1 - \frac{1}{r}\right)} = \frac{0.58(1941.6 - 888.3)}{\frac{0.287 \cdot 300}{95}\left(1 - \frac{1}{16}\right)}$

$\boxed{724 kPa}$

(57) Diesel





2,4 $r = 22$ $r_c = 1,18$ T_1 70°C = 343,15K

$p_1 = 97 kPa$ $N = 3500$

$$W = n_{gIN} = \left(1 - \frac{1}{k}\frac{r_c^k - 1}{r^{k-1}(r_c - 1)}\right) c_p (T_3 - T_2)$$

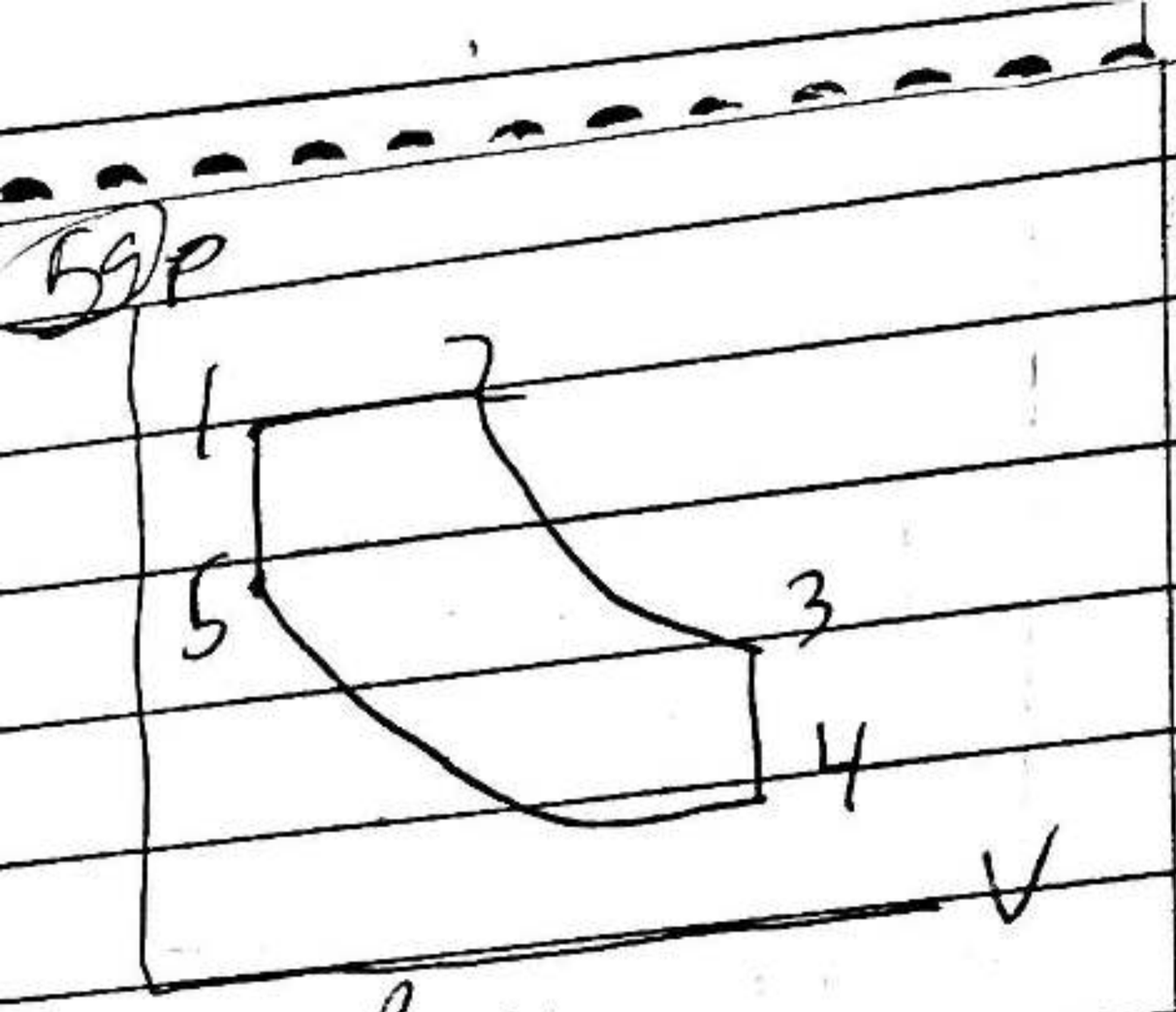
$$= \left(1 - \frac{1}{k}\frac{r_c^k - 1}{r^{k-1}(r_c - 1)}\right) c_p T_1 r^{k-1}(r_c - 1)$$

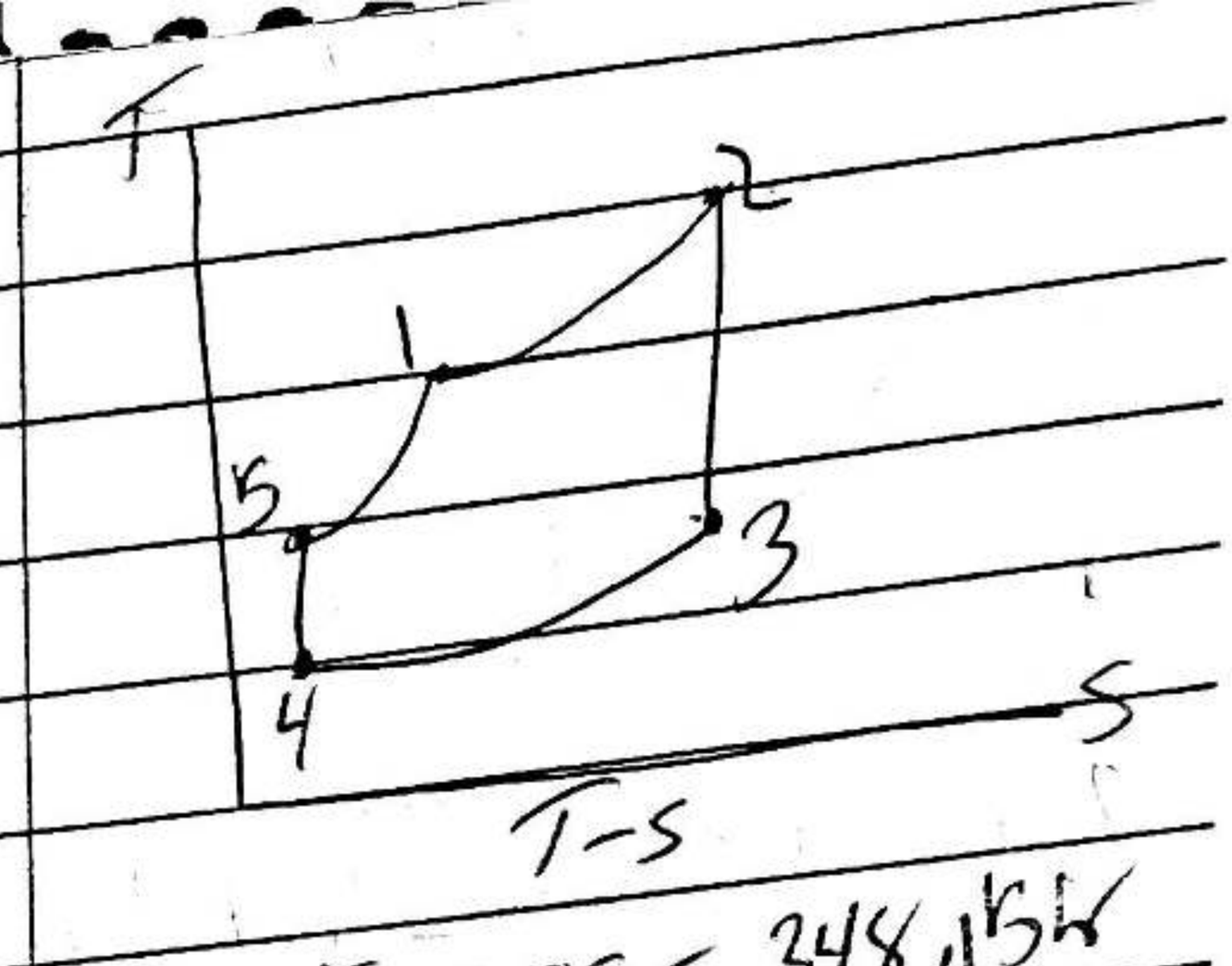
$$= \left(1 - \frac{1}{1.4}\frac{1,8^{1.4} - 1}{1.4\ 22^{1.4-1}(1,8-1)}\right) \cdot 1,005 \cdot 343 \cdot 22^{1.4-1} \cdot (1,8-1)$$

$$\frac{635\ kJ}{kg}$$

$$W = mw = \frac{N p_1 V}{R T_1} w = \frac{3500\ 97,25 \cdot 10^{-3} \cdot 635}{60\ 0,287 \cdot 343}$$

$$= 91,2 kW$$





$r_c = 1.4 \quad r = 15 \quad P_1 14.2 \quad T_1 \; 75°F = 348.15K$

$q_{in} = q_{2-x} + q_{x-3}$

$C_v(T_x - T_2) + c_p(T_3 - T_x)$

$C_v T_1 r^{k-1}\left(\frac{P_x}{P_2} - 1\right) + c_p \frac{P_x}{P_2} T_1 r^{k-1}(r_c - 1)$

$(0.171 \cdot 535 \cdot 15^{1.4-1}(1.1 - 1) + 0.24 \cdot 1.1 \cdot 535 \cdot 15^{1.4-1}(1.4 - 1)$

$= \boxed{193.9 \frac{BTU}{lbm}}$

$w = q_{in} - q_{out}$

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

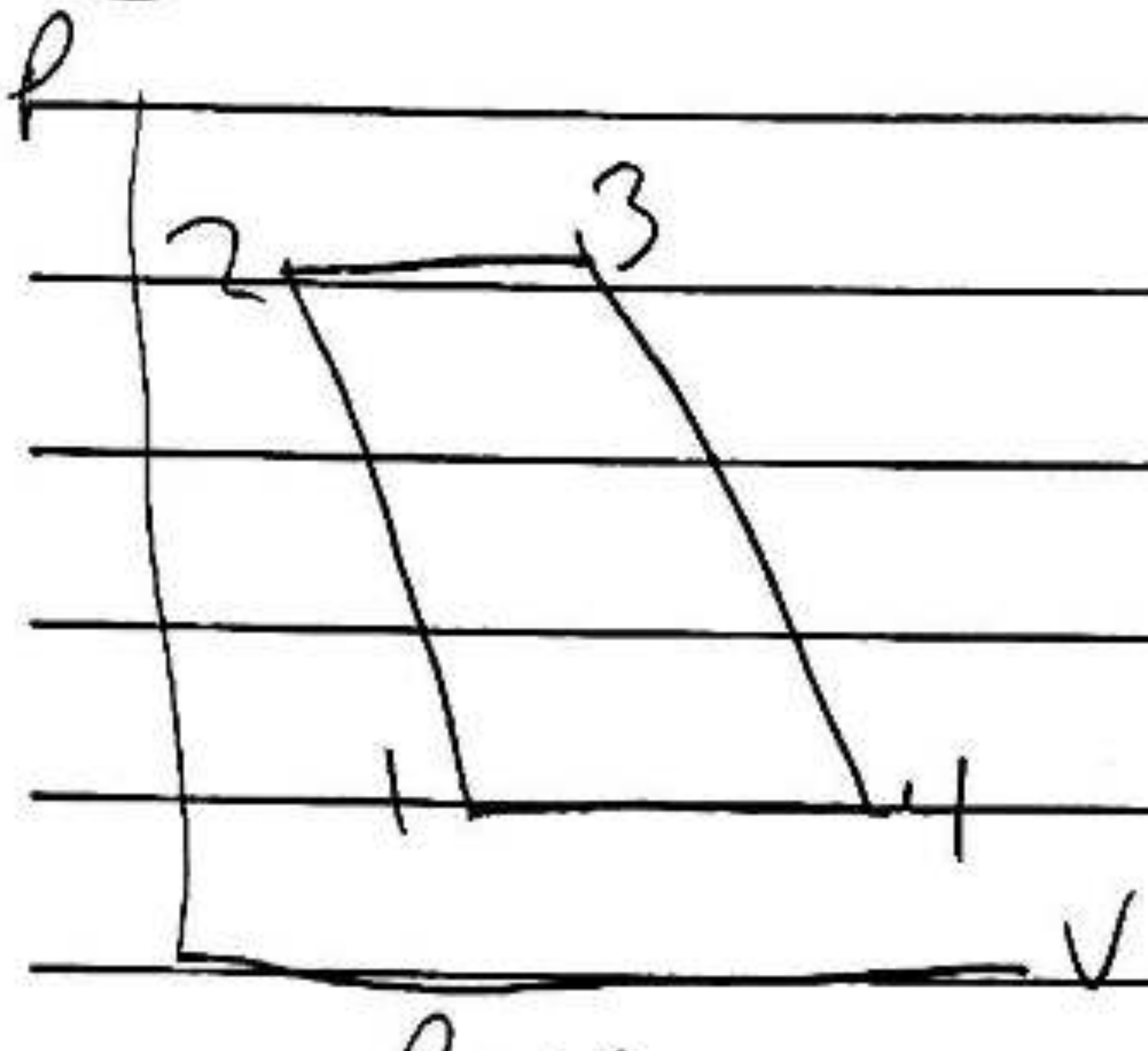
$q_{in} - C_v T_1\left(r_c^k \frac{P_x}{P_2} - 1\right)$

$\left(193.9 - 0.171 \cdot 535\left(1.4^{1.4} \cdot 1.1 - 1\right)\right)$

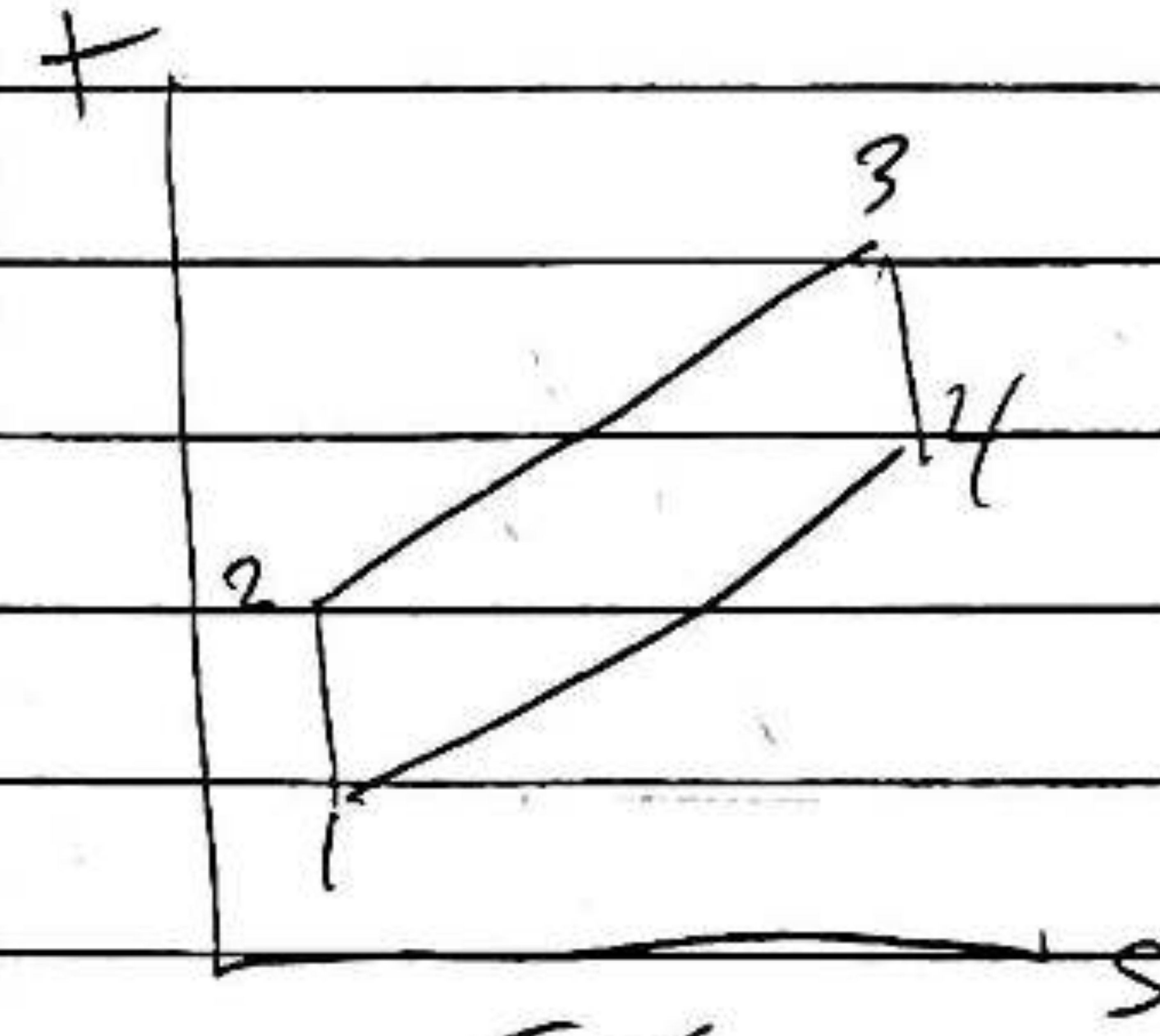
$\boxed{124.2 \frac{BTU}{lbm}}$

$n = \frac{w}{q_{in}} = \frac{124.2}{193.9} = \boxed{0.646}$

(80)



P-v



T-S

(a) $520_R =$ $2000R$; $r = 10$

$h_1 = 124.27$ Btu/lbm

$P_{r1} = 1.2147$

$P_{r2} = r_p P_{r1} = 10 \cdot 1.2147 = 12.147$
≈ 12.30

$h_2 = 240.98$ Btu/lbm

$T_2 = 1000R$

(b) $h_3 = 504.71$ Btu/lbm

$P_{r3} = 174$

$P_{r4} = \frac{P_{r3}}{r_p} = \frac{174}{10} = 17.4 \approx 16.28$

$h_4 = 260.97$ Btu/lbm

(c)

$$\eta = \frac{w}{q_{in}}$$

$$= \frac{w}{h_3 - h_2} = 1 + \frac{h_1 - h_4}{h_3 - h_2}$$

$$= 1 + \frac{124.27 - 260.97}{504.71 - 240.98}$$

$$= 0.4817$$