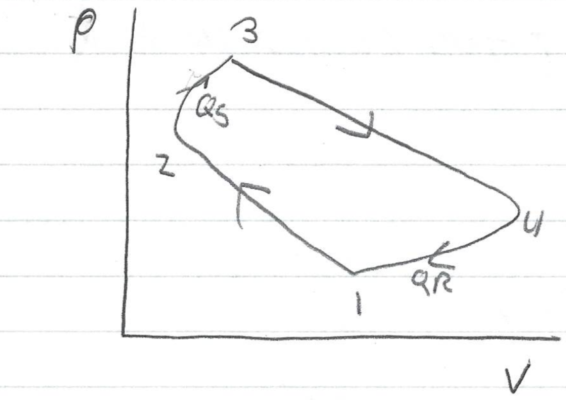
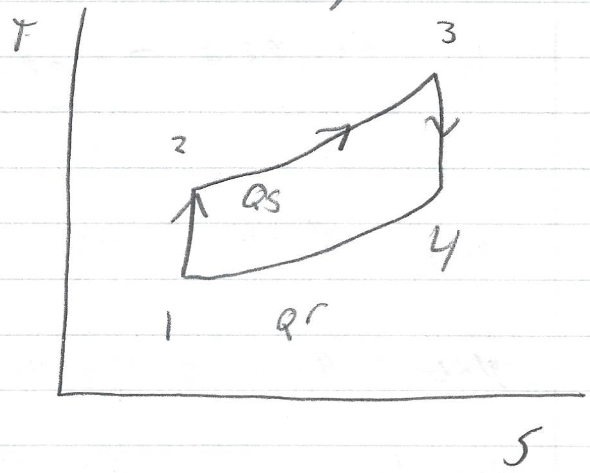
Thermal applications HW1 Ben Smithson

13.





① ② ③ ④

$P_1 = 100 kPa$ $T_1 = 295 K$

$P_2 = 600 kPa$ $T_2 = 500 K$

$T_3 = 1500 K$ $P_{r2} = 7.84$

$P_4 = 100 K$

$h_1 = 295.17$. $P_{r1} = 1.3068$

$$\frac{P_{r2}}{P_{r1}} = \frac{P_2}{P_1} = \frac{P_{r2}}{1.3068} = \frac{600}{100} \qquad P_{r2} = 7.84$$

$P_{r2} = 7.84$

A-17 $U_2 = 352.08 + \frac{7.84 - 7.83}{8.4 - 7.83} (359.4 - 352.08 = 352.28$ kJ/kg

$T_2 = 490.3$ K

$U_3 = 1205.41 = P_{r3} = 601.9 \qquad P_3 = 1835.7$ kPa

$$\frac{P_{r4}}{P_{r3}} = \frac{P_4}{P_3} = \frac{P_{r4}}{601.9} = \frac{100}{1835.72} = 32.78$$

$$h_4 = 734.82 + \frac{32.78 - 32.02}{33.72 - 32.02}(745.62 - 734.82)$$

$$h_4 = 739.64 \text{ kJ/kg}$$

$$w_{net} = q_s - q_r = (u_3 - u_2) - (h_4 - h_1)$$

$$w_{net} = (1205.4 - 352.28) - (739.64 - 295.17)$$

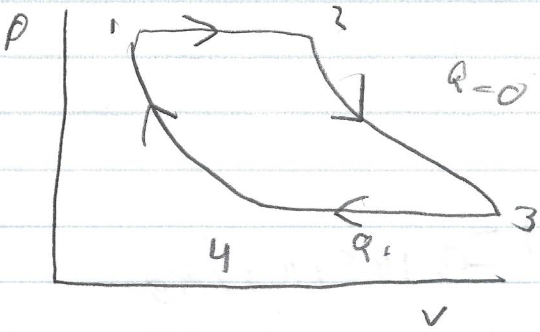
$$w_{net} = 408.66 \text{ kJ/kg}$$

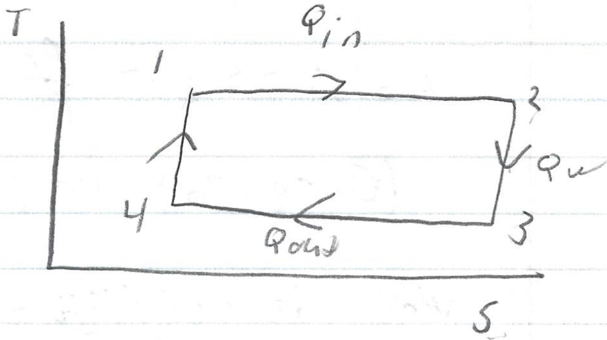
$$n_{th} = \frac{w_{net}}{q_s} = \frac{w_{net}}{u_3 - u_2}$$

$$= \frac{408.66}{1205.4 - 352.28} = 47.9\%$$

Therman applications Ben Smithson HW 1

18.





$T_H = 1200K$

$T_L = 350K$

Wnet = 0.8 kJ

① ② ③ ④

①	②	③	④
$T_1 = 1200K$	$T_2 = 1200K$	$T_3 = 350K$	$T_4 = 350K$
$P_{R1} = 23K$	$P_{r2} = 23K$	$P_{r3} = 2379$	$P_{r4} = 2.38$
$P_1 = 30.0\,MPa$	$s^\circ_2 = 3.178$	$P_3 = 150\,kPa$	$P_4 = 300\,kPa$
$s_1 = 3.19$		$s^\circ_3 = 1.857$	$s^\circ_4 = 1.587$

$$\frac{P_1}{P_4} = \frac{P_{r1}}{P_{r4}}$$

$$P_1 \left(\frac{238}{2.379}\right)(300\,kPa) \quad P_1 = 30.012.6 = 30.01\,MPa$$

Wnet = Qin − Qout

$$n_{th} = 1 - \frac{350K}{1200K} = 0.7083$$

Qin = 0.5 kJ / 0.709 = 0.700 kJ

$ds = \frac{80}{q}$

$ds = (s_1 - s_2) - \frac{P_r}{P_3}$

$(0.08 \cdot 70) \cdot \ln\left(\frac{300K}{180K}\right) = 0.1984 \, KJ/Kg$

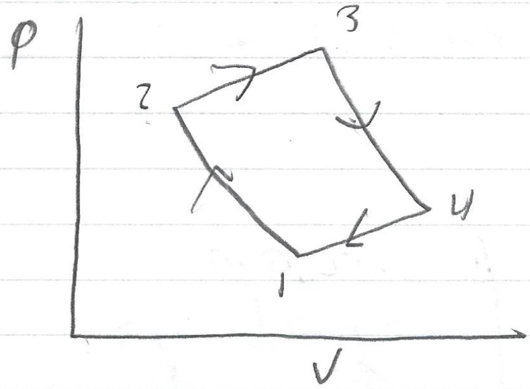
?

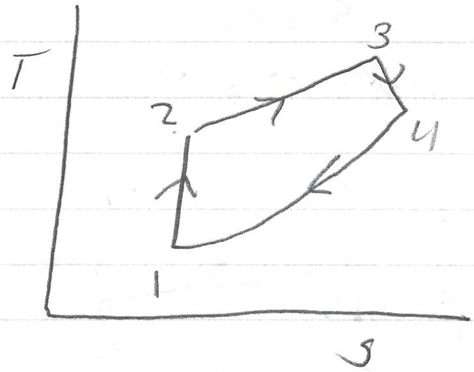
$w_{net} = 0.1989 \, (1200 - 350) K$

$m_{air} = \frac{0.5 \, Kg}{169.09} = 0.0023 \, Kg$

Thermal applications   Ben Smithson   HW 1

22





$T_1 V_1^{k-1} = T_2 V_2^{k-1}$

① ② ③ ④

$T_1 = 20°C = 293K$ $\quad$ $T_2 = 583.5K$ $\quad$ $T_3 = 2917.4$

$V_1 = 1$ $\quad$ $V_2 = 0.7$

$T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{k-1}$ $\quad$ $k = \frac{C_P}{C_V} = \frac{1}{0.7} = 1.43$

$293 \times 5^{1.43-1} = 583.5K$

$W_{1\to2} = \frac{R(T_1 - T_2)}{k-1} = \frac{0.3}{1.43 - 1} \cdot (293 - 583.5) = 203.6 \frac{kJ}{kg}$

$q_{2-3} = C_P(T_3 - T_2) = 1 \cdot 2917 - 583.43 = 2333.9\ kJ/kg$

$W_{2-3} = q_{2\to3} - C_V(T_3 - T_2) = 2333.9 - 0.7(2917.4 - 583.5) = 700.18 \frac{kJ}{kg}$

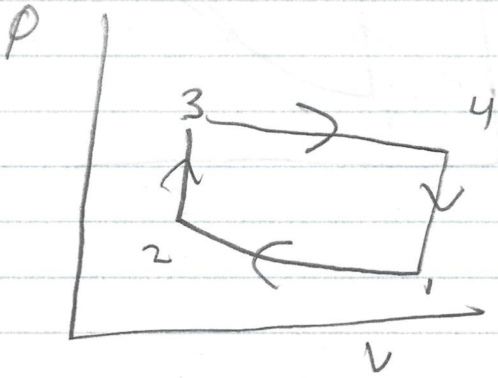
b. $q_{3\to1} = C_V(T_3 - T_1) = 1837.01\ kJ/kg$

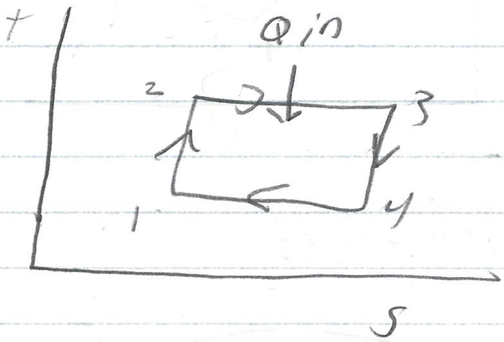
c. $\eta_{th} = 1 - \frac{q_r}{q_s} = \frac{q_{3\to1}}{q_{2\to3}} = \frac{1837}{2333} = 21\%$

d.?

31

$$\frac{90\,kPa}{40°C = 313.15K} = 2500\,rpm = 90\,kW$$





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

$$T_2 = (313.15)(10.5)^{1.4-1} = 802K$$

$$\eta_{th} = 1 - \left(\frac{313.15}{82}\right) = 0.6095 = 60.9\%$$

$$Q_{in} = \frac{90\,kW}{0.609} = 148\,kW$$