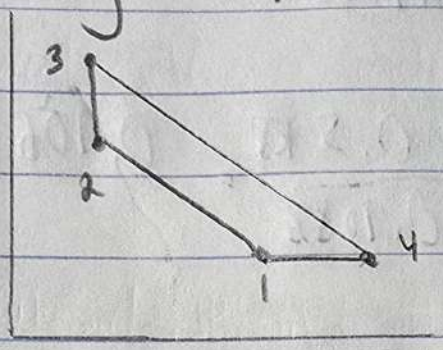
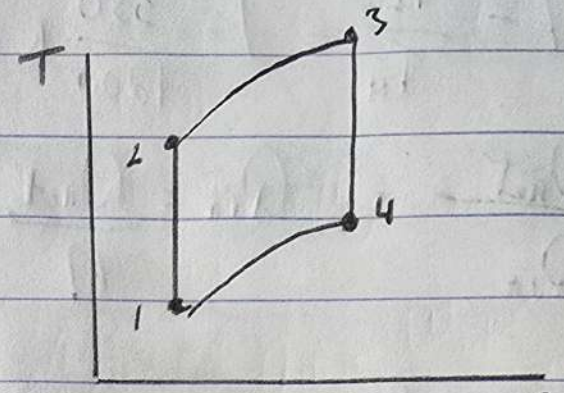
HW 1.2

Jeffrey Redmond

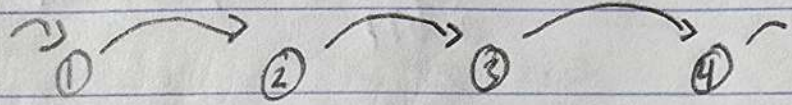
9-13

(a)





(b)



$P_1 = 100 kPa$ $P_2 = 600 kPa$ $P_3 = 1102 kPa$ $P_4 = 100 kPa$

$T_1 = 501 K$ $T_2 = 817$ $T_3 = 1500 K$ T_4 $861 K$

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

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

$$T_2 = 501 K \cdot \left(\frac{600}{100} kPa\right)^{\frac{1.37-1}{1.37}}$$

$$T_2 = 817 K$$

$$P_3 = P_2 \frac{T_3}{T_2}$$

$$P_3 = 600 \cdot \frac{1500}{817} K = 1102 kPa$$

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

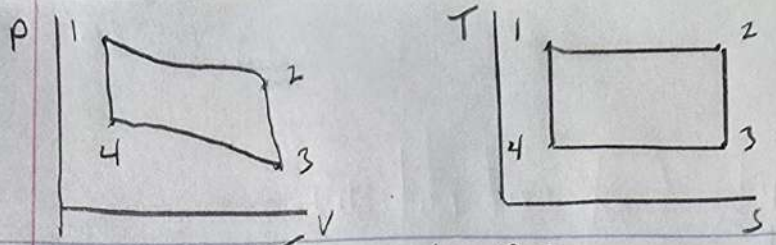
$$T_4 = 1500 \left(\frac{100}{1102}\right)^{\frac{1.272-1}{1.272}} = 861 K$$

$$Q_{in} = C_{v_{avg}}(T_3 - T_2) = 0.8865(1500 - 817) = 605 kJ/kg$$

$$Q_{out} = C_{v_{avg}}(T_4 - T_1) = 1.058(861 - 501) = 381 kJ/kg$$

$$W_n = Q_{in} - Q_{out} = 605 - 381 = 224 kJ/kg$$

(c) $$\eta_{th} = \frac{W_n}{Q_{in}} = \frac{224}{605} = 0.37 = 37\%$$



KPa

350 K = 2.374

1200 K = 238 KPa

9-18 $\eta = 1 - \frac{T_L}{T_H} = 1 - \frac{350}{1200} K = 0.7083$

b) $\eta = \frac{W_{net}}{Q_{in}} = Q_{in} = \frac{W_{net}}{\eta} = \frac{0.5\ KJ}{0.7088} = 0.706\ KJ$

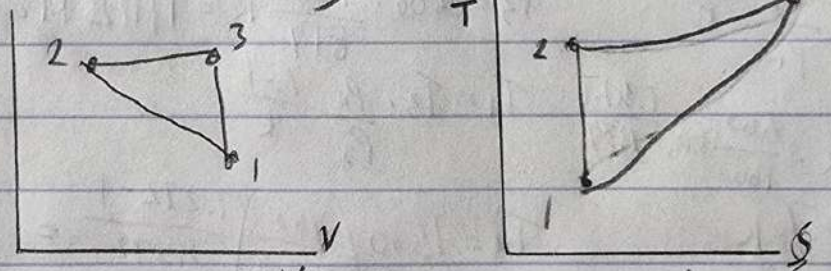
a) $P_1 = P_4 \cdot \frac{P_1}{P_4} = 300 \cdot \frac{238}{2.374} = 30,012\ KPa$ or $30\ MPa$

c) $m = \frac{W}{R \ln\left(\frac{P_4}{P_3}\right)(T_H - T_L)} = \frac{0.5}{0.287 \ln\left(\frac{300}{150}\right)(1200 - 350)}$

$m = 0.00296\ kg$

9-22

a)



b) $c_p - c_v = R \quad c_p = 0.3 + 0.7 = 1\ KJ/kg \cdot K \quad \frac{c_p}{c_v} = \frac{1}{0.7} = 1.428$

(1) → (2)

$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{k-1} \quad T_2 = 293(5)^{1.428-1} = 583.47\ K$

$W_{1-2} = c_v(T_1 - T_2) = 0.7(293 - 583.47) = -203.335\ \frac{KJ}{KJ}$

(2) → (3)

$\frac{T_3}{T_2} = \frac{V_3}{V_2} \quad T_3 = 583.47 \cdot 5 = 2917.4\ K$

$W_{2-3} = c_p(T_3 - T_2) - c_v(T_3 - T_2)$

$= 2333.93 - 0.7(2917.4 - 583.47) = 700.179\ \frac{KJ}{KJ}$

$q_{2-3} = c_p(T_3 - T_2)$

$= 1(2917.4 - 583.47) = 2333.93\ \frac{KJ}{KJ}$

$q_{3-1} = c_v(T_3 - T_2) = 0.7(2917.4 - 293) = 1837.687\ \frac{KJ}{KJ}$

$W_{3-1} = 0$

c) $\eta = 1 - \frac{q_{out}}{q_{in}} = 1 - \frac{1837.067}{2333.93} = 21.28\%$

Q-3) $\eta = 1 - \frac{1}{r^{k-1}} = 1 - \frac{1}{10.5^{1.4-1}} = 60.95\%$

$Q = \frac{W}{\eta} = \frac{90}{0.6095} = 147.64 \text{ kW}$

$\eta = 1 - \frac{1}{8.5^{1.4-1}} = 57.51\%$

$Q = \frac{90}{0.5751} = 156.48 \text{ kW}$