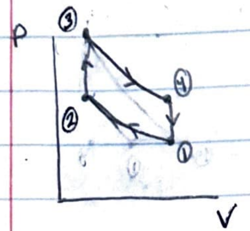
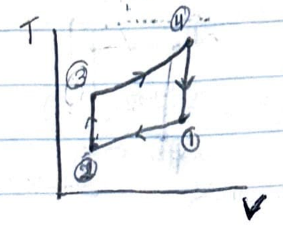
1/28/2025
Michael O'Brien

HW 1.2 CH9: 13, 18, 22, 31

Q 9-13. Air Standard Cycle, variable specific heats is executed in closed system with 4 processes:
1-2 Isentropic Compression 100 kPa and 22°C to 600 kPa
2-3 V= Constant heat to 1500 K
3-4 Isentropic Expansion to 100 kPa
4-1 P=Constant heat rejection

Q's
* Does the isentropic compression lose volume?
* Act more like an otto cycle





(1) → Isentropic Compression → (2) → const → (3) → Isentropic Expansion → (4) → Pconst →

$P_1 = 100$ kPa, $P_2 = 600$ kPa, $T_3 = 1500$ K, $P_4 = 100$ kPa

$T_1 = 22°C = 295.15$ K

$T_2 = \frac{P_2}{P_1} T_1$

$T_2 = \frac{600 \text{ kPa}}{100 \text{ kPa}} \cdot 295.15$ K

~~$T_2 = 1,770.9$~~

$q_{out} = 1500\text{K} - 295.15\text{K}$

$q_{out} = 1204.85$ K

$\eta = \frac{W_{net}}{q_{in}} = 1 - \frac{Q_{out}}{Q_{in}}$

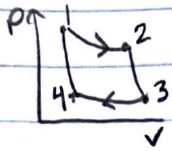
$q_{in} - q_{out} + W_{in} - W_{out} = \Delta u \left[\frac{kJ}{kg}\right]$

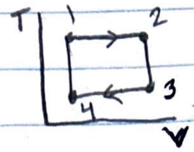
~~1-1209.85k+00 kPa-~~

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

$\frac{T_4}{1500\text{ K}} = \left(\frac{100 \text{ kPa}}{}\right.$?

Q. 18 Air Standard Carnot Cycle is executed in a closed system between temps 350 k and 1200 k. Pressure before and after isothermal compression are 150 kPa and 300 kPa. Net work out is 0.5 kJ.





$\Delta W_{out} = 0.5\,kJ$

① Isothermal → Expansion → ② → Expansion ③ → Isothermal compression ④ → compression   Sp. air = 1.4

$P_1 = 150\,kPa$, $T_1 = 1200\,K$

$T_2 = 1200\,k$, $P_2 = 300\,kPa$

$T_3 = 350\,k$

$T_4 = 350\,k$

$n = 1 - \frac{T_L}{T_H}$ $n = \frac{W_{net}}{Q_{in}}$

$= 1 - \frac{350}{1200} = 1 - 0.2917$

$n = 0.7083$

$0.7083 = \frac{.5}{Q_{in}}$

$\frac{T_3}{T_2} = \left(\frac{P_3}{P_2}\right)^{\frac{k-1}{k}}$

$\frac{350}{1200} = \left(\frac{P_3}{300}\right)^{\frac{1.4-1}{1.4}}$

~~$0.2917 = \left(\frac{P_3}{300}\right)^{0.286}$~~

~~$\frac{P_3}{300} = 1.67$~~

Q22 An Ideal gas is contained in a piston cylinder device and undergoes power cycle.

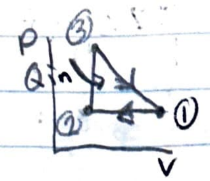
① Isentropic compression → ② Constant Pressure/heat add → ③ → constant Volume/heat rejection

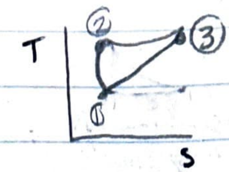
$c_v = 0.7$ kJ/kg·k
$R = 0.3$ kJ/kg·k

$T_1 = 20°C$

$r = 5$

* need T_2





$T_2 = T_1 r^{k-1}$

$W_{1-2} = c_v (T_2 - T_1)$

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

$.7 + .3 = 1.0$ kJ/kg

$Q_{3-1} = 0.7 (T_3 - 293)$

$W_{net} = Q_2 - Q_1$

$\eta = \frac{W_{net}}{Q_{in}}$

$W_{net} =$

Q 31. Ideal Otto cycle has compression ratio of 10.5, takes air at 90 kPa and 40°C, 2500 rpm. Find Thermal Efficiency to produce 90 kW of Power.

(1) (2)

$P_1 = 90\ kPa$

$T_1 = 40°C = 313.5\ K$

$$n = 1 - \frac{1}{r^{k-1}}$$

$$n = 1 - \frac{1}{10.5^{1.4-1}}$$

$$n = 1 - 0.60$$

$$n = 0.39$$