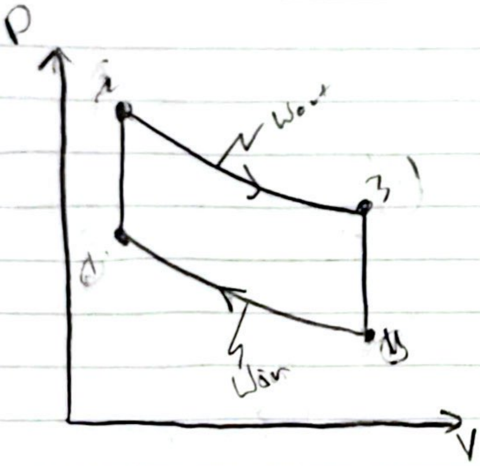
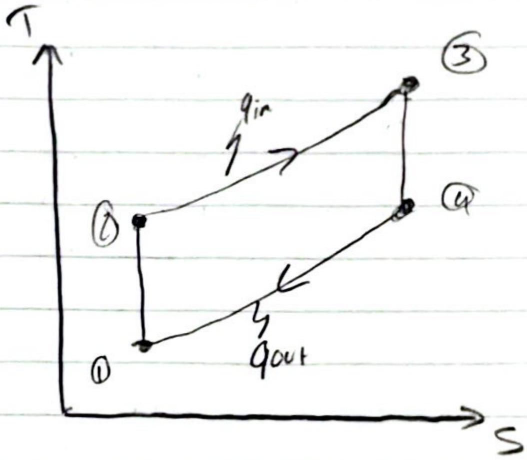
Homework 1.2

9-13) An air standard cycle w/ variable specific heats is executed in a closed system and is composed of the following 4 Proc

1-2 isentropic compression from 100 kpa and 22°C to 600 KPA
2-3 v const heat addition to 1500 K
3-4 isentropic expansion to 100 kpa
4-1 P = Constant heat rejection to initial state





$\rightarrow 1 \xrightarrow{\text{isentropic compression}} 2 \xrightarrow{V = \text{const}} 3 \xrightarrow{\text{isentropic expansion}} 4 \xrightarrow{P = \text{const}}$

1

$P_1 = 100$ KPA

$T_1 = 22°C = 295K$

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

$$\frac{100}{600} = \frac{295K}{x}$$

$100x = 177000$

$T_2 = 1770$

2

$P_2 = 600$ KPA

$T_2 = 1770$

$P_2 V_2 = RT_2$

$600(V_2) = (1770)(.287)$

$$V_2 = \frac{(1770)(.287)}{600}$$

$V_2 = 0.84665$

3

$T_3 = 1500K$

$V_3 = 0.84665$

$P_3 V_3 = RT_3$

$$P_3 = \frac{RT_3}{V_3} = \frac{(.287)(1500)}{0.84665}$$

$P_3 = 508.475$

4

$P_4 = 100$ KPA

$$\frac{P_3}{P_4} = \frac{T_3}{T_4}$$

$$\frac{508.475}{100} = \frac{1500}{T_4}$$

$T_4 = 295K$

b) Calculate the net Work output per unit Mass

$W_{net} = W_{out_{3-4}} - W_{in_{1-2}}$

$W_{out_{3-4}} = \frac{kR(T_3 - T_4)}{k-1}$ $R = .2870$ $k = 1.4$

$= \frac{(1.4)(.2870)(1500-295)}{1.4-1}$

$= 1210.42$

$W_{in} = \frac{kR(T_2 - T_1)}{k-1}$

$= \frac{(1.4)(.2870)(1770-295)}{1.4-1}$

$= 1481.63$

$1210.42 - 1481.63 = -271.21$??

Did something wrong

c) Determine The Thermal Efficiency

$\eta_{th} = \frac{W_{net}}{q_{in}} = \frac{-271.21}{0} = 0$??

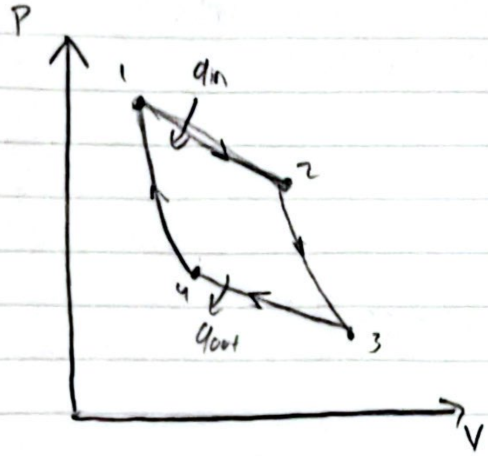
$q_{in} = C_v(T_4 - T_2)$

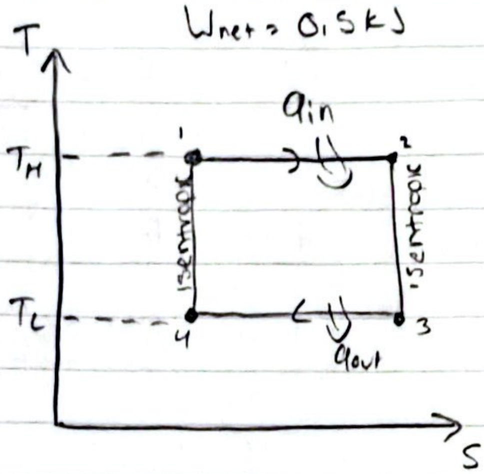
$C_v(0)$

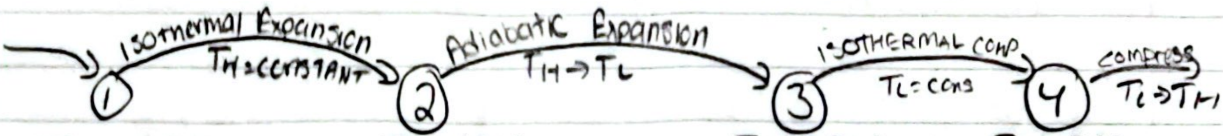
$q_{in} = 0$

Something Wrong w/ T_4

9-58 An air standard Carnot Cycle is executed in a closed system between the temperature limits of 350 and 1200 K. The pressures before and after the isothermal compression are 150 and 300 kPa, respectively. The net work output is 0.5 kJ







$T_{H_1} = 1200$ K

$T_H : 1200$ K

$T_L = 350$ K

$P_3 = 150$ kPa

$T_L = 350$ K

$P_4 = 300$ kPa

$$W_{net} = W_{in_{1-2}} - W_{out_{3-4}}$$

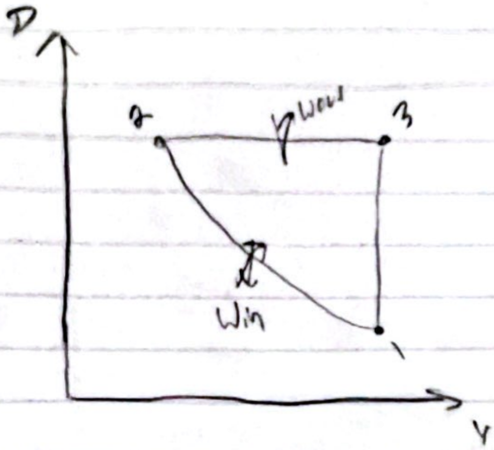
9-22 An ideal gas is contained in a piston cylinder device and undergoes a Power cycles

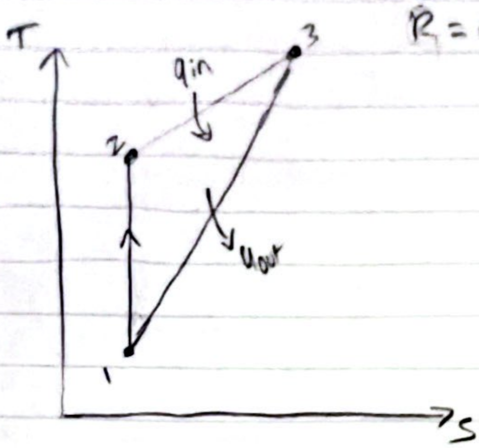
1-2 Isentropic compression from an initial temperature
- $T_1 = 20°C$ with a compression Ratio of $r = 5$

2-3 Constant Pressure heat addition

3-1 Constant Volume heat rejection

$C_v = 0.7$
$R = 0.3$





$\rightarrow (1) \xrightarrow{\text{isentropic compression}} (2) \xrightarrow{P = const} (3) \xrightarrow{V = const}$

(1): $T_1 = 20°C = 293 K$, $V_1 = 5$

(2): $V_2 = \frac{V_1}{5}$, $T_2 = 147.24 K$

(3): $V_3 = V_1$, $P_3 = P_2$

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

$$\frac{293}{T_2} = (5)^{1.428-1}$$

$$\frac{293}{1.99} = (T_2)(1.99)$$

$T_2 = 147.24$

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

$$\frac{147.24}{293} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$$

$C_p = C_v + R$
$C_p = 0.7 + 0.3$
$C_p = 1$

$k = \frac{C_p}{C_v} = \frac{1}{0.7} = 1.428$

Determine the heat and work interactions between the processes

$$W_{in_{1-2}} = \frac{kR(T_2 - T_1)}{k-1}$$

$$= \frac{1.428(0.3)(293 - 147.24)}{1.428 - 1}$$

$W_{in} = 145.89$

$$W_{out} = \frac{kR(T_2 - T_3)}{k-1}$$

$= 1.428(0.3)($

??

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

$q_{out} = C_v(T_3 - T_2)$

$= 0.7($

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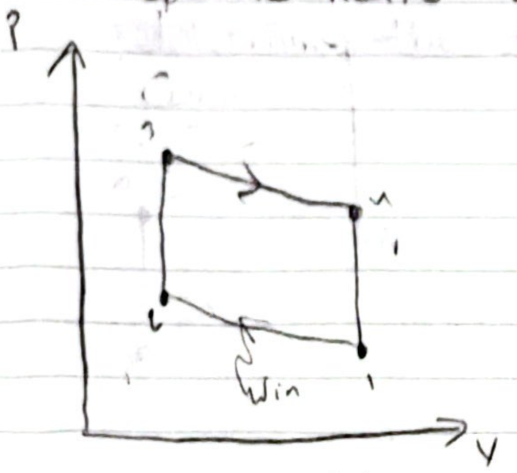
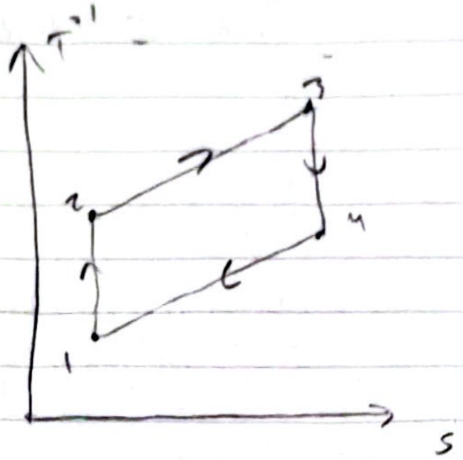
9-31 An ideal otto cycle has a Compression ratio of 10.5, takes in air at 90 kPA and 40°C, and is repeated 2500 per minute. Using constant Specific heats at room temperature,





$r = 10.5$

$$\rightarrow (1) \xrightarrow{\text{isentropic}} (2) \xrightarrow{V=\text{const}} (3) \xrightarrow{\text{isentropic}} (4) \xrightarrow{V=\text{const}}$$

State 1

$T = 40°C = 313\,K$

$P = 90\ kPA$

$V_1 = 1.0329$

$PV = RT$

$V = \frac{(.287)(313)}{90}$

$V = 1.0329$

$\frac{P_1}{P_2} = \frac{V_1}{V_2}$

$\frac{90}{x} = \frac{1.03}{10.8}$

State 2

$V_1 = \frac{10.5}{V_2}$

$V_2 = 10.5 \cdot V_1$

$V_2 = 10.84545$

$P_2 = 943.69\ kPA$

$(943.69)(10.8) = (0.28)(T)$

$T_2 = 36399\ kPA$

State 3

$V_3 = V_2$

$V_3 = 10.85$

State 4

$V_4 = V_1$

$V_4 = 1.0329$

Determine the thermal efficiency of this cycle and the rate of heat input if the cycle is to produce 90 kW of power.

$W_{net} = 90\ kW$

$90 = W_{in,1-2} - W_{out,3-4}$