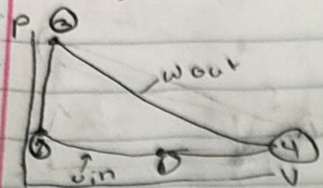
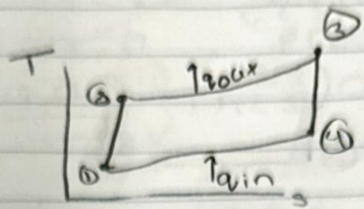
Aaligah Ashley 1/18/23

HW 1.2

9-13)





$273 + 22 = 295\,K$ $\quad C_P = 1.005\ kJ/kg\cdot K$ $\quad c_v = 0.718\ kJ/kg\cdot K$

$R = c_p - c_v = 0.287\ kJ/kg\cdot K$ $\quad k = c_p/c_v = 1.4$

State 1 $\xrightarrow{\text{isentropic compress}}$ State 2 $\xrightarrow{v\ \text{constant}}$ State 3 $\xrightarrow{\text{isentropic ex}}$ State 4 $\xrightarrow{P\ \text{constant}}$

State 1

$P_1 = 100\ kPa$

$T_1 = 295\ K$

$v_1 = \frac{RT_1}{P_1} = \frac{(0.287\ kJ)(295)}{100}$

$= 0.847\ m^3/kg$

$h_1 = 295.17\ kJ/kg$

State 2

$P_2 = 600\ kPa$

$\frac{v_2}{v_1} = \left(\frac{100}{600}\right)(0.847)$

$= 0.1412\ m^3/kg$

$\frac{T_2}{T_1} = \left(\frac{0.847}{0.1412}\right)^{0.4}(295)$

$= 604\ K$

$u_2 = 438.1$

State 3

$T_3 = 1500$

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

$= P_3 = \frac{1500}{604}(600)$

$= 1510\ kPa$

$v_3 = \frac{(0.287)(1500)}{1510}$

$= 0.276$

$u_3 = 1205.41$

State 4

$P_4 = 100\ kPa$

$\frac{v_4}{v_3} = \left(\frac{100}{1500}\right)(0.276)$

$v_4 = 0.01827$

$\frac{T_4}{T_3} = \left(\frac{v_3}{v_4}\right)^{k-1}$

$T_4 = \left(\frac{0.276}{0.01827}\right)^{0.4}(1500)$

$= 4443.85$

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

$W_{out_{3-4}} = \frac{0.287(4443.85 - 1500)}{1 - 1.4} = 2112.21$

$W_{in} = 0.287\frac{(604 - 295)}{0.4} = 221.71$

$W_{net} = 1890.5$

c) $0.718\ kJ/kg\,(1500 - 600) = 646.2$

$\eta_{th} = 0.341$ or 34%

9-18) $T_1 = 350\,K$ $T_4 = 1200\,K$

$P_1 = 150\,kPa$ $P_4 = 300\,kPa$

$P_{r_1} = 2.379$ $P_{r_4} = 238$

$300\left(\frac{238}{2.379}\right) = \boxed{30\ MPa}$

$W_{out} = 0.5\,kJ$

$\eta_{th} = 1 - \frac{Q_L}{Q_H} = 1 - \left(\frac{350}{1200}\right) = 0.708$

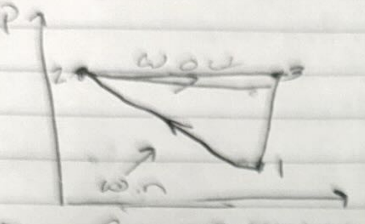
$\frac{W_{out}}{\eta_{th}} = \frac{0.5}{0.708} = \boxed{0.706\ kJ}$

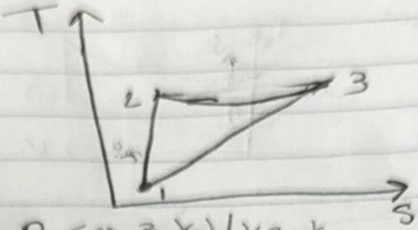
$0.287 \ln\left(\frac{300}{150}\right) = 0.1989$

$(1200 - 350)(0.1989) = 169.093 \frac{kJ}{kg}$

$\frac{0.5}{169.093} = \boxed{0.00295\ kg}$

9-22)





$r=5$ $C_v = 0.7\ kJ/kg\cdot K$ $R=0.3\ kJ/kg\cdot K$ $c_p = 1$ $k=1.43$

State ① $\xrightarrow{\text{isentropic compression}}$ State ② $\longrightarrow$ State ③

$T_1 = 293\ K$

$\frac{T_2}{298} = (5)^{(1.43-1)}$ $\frac{293}{T_3} = (5)^{1.43} = 2926.8\ K$

$T_2 = 585.36\ K$

$W_{1-2} = \frac{0.3(585.36-293)}{1-1.43} = -203.97\ kJ/kg$

$Q_{2-3} = c_p(T_3 - T_2) = 1(2926.8 - 585.36) = 2341.44\ kJ/kg$

$W_{2-3} = 0.3(2926.8 - 585.36) = 702.43\ kJ/kg$

η $0.7(2926.8 - 293) = 1843.66$

$1 - \left(\frac{1843.66}{2341.44}\right) = 0.2125 = \boxed{21.3\%}$

$\eta = 1 - \frac{(T_3 - T_1)}{k(T_3 - T_2)}$

$= 1 - \frac{\left(1 - \frac{T_1}{T_3}\right)}{k\left(1 - \frac{T_2}{T_3}\right)}$

$1 - \frac{(r^k - 1)}{k(r-1)}$

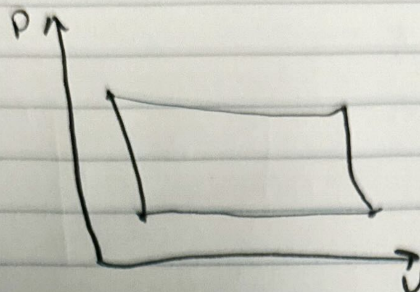
9-31)

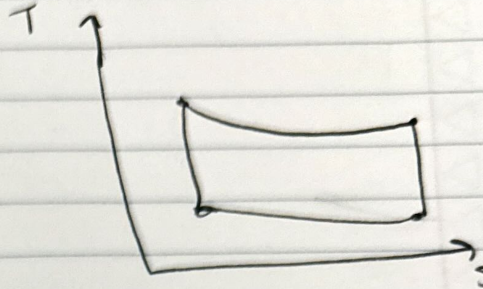
r = 10.5

P = 90 KPa

T = 313 K

Power = 90 Kw





$1 - \frac{1}{(10.5)^{0.4}} = 0.6095$

$\boxed{60.95\%}$.

$\omega = 90 \times \frac{60}{2500}$

$= 2.16 \text{ KJ}$

$\frac{2.16}{0.695} = \boxed{3.543 \text{ KJ}}$