1. $k=1.4$ $\quad \frac{P_2}{P_1}=10$ $\quad \eta=.85$

a)

$$.85=\frac{10^{\frac{.4}{1.4}}-1}{10^{.4/1.4}\cdot\frac{1}{\eta_p}-1}$$

$$\Rightarrow \eta_p=.89 \Rightarrow 89\%$$

b) $\eta_p=1$ $\Rightarrow$ $\eta=1-\left(\frac{1}{r_p}\right)^{\frac{k-1}{k}}\Rightarrow .53$

2. $R=287$ $\quad \dot{m}=115$ $\quad k=1.4$

$P_1=.7$ $\quad P_2=8$ bar $\quad \eta_p=.9$

a) $\eta=\dfrac{(8/.7)^{\frac{.4}{1.4}}-1}{(8/.7)^{.4/1.4}\cdot\frac{1}{.9}-1}=86.2\%$

b) $\eta=\dfrac{c_p(T_{2s}-T_1)}{c_p(T_2-T_1)}$ $\Rightarrow$ $\dfrac{T_{2s}}{T_1}=\left(\dfrac{P_2}{P_1}\right)^{\frac{k-1}{k}}$

$$\Rightarrow \frac{T_{2s}}{T_1}=2.006$$

$$.8618=\frac{2.006-1}{T_2/T_1-1} \Rightarrow \frac{T_2}{T_1}=2.167$$

$$\Delta S=115\left[1.005\ln(2.167)-.287(\ln 8/.7)\right]=\boxed{8.98}$$

3. $P_1 = 25$ MPa $P_2 = 3$ MPa

$\dot{m} = 22$ (Superheated @ 500°C)

exit (Saturated Vapor)

a) $h_1 = 3165.92$ $h_g = 2803.265$

$s_1 = 5.9642$ $h_f = 1000.371$

$s_g = 6.165$

$s_f = 2.6456$

$s_1 = s_f + x(s_g - s_f) \Rightarrow .936 = x$

$\Rightarrow h_2 = 2691.49$

$\Rightarrow P = \dot{m}(h_1 - h_2) \Rightarrow \boxed{P = 10437 \text{ kW}}$

$\Rightarrow \eta = \frac{h_1 - h_g}{h_1 - h_2} \Rightarrow \boxed{.764}$

4. otto cycle $r_c = 9$, $k = 1.4$

$\eta_{otto} = 1 - \frac{1}{r_c^{k-1}} \Rightarrow .565$

$\eta_{otto} = \eta_d$

$.565 = 1 - \frac{1}{r^{k-1}} \cdot \left(\frac{r^k - 1}{k(r-1)}\right) \Rightarrow r = \frac{3V_c}{V_2} = 3$

$\Rightarrow \frac{1}{r^{.4}} = \frac{.415}{1.3055} \Rightarrow \boxed{r = 17.5}$

5.9) $T_1 = 298\ K$ $\quad r = 9 = V_1/V_2$ $\quad k = 1.4$

$P_1 = 1\ bar$ $\quad r_c = \frac{V_4}{V_3} = 13$

$T_2/T_1 = (V_1/V_2)^{k-1}$ $\rightarrow$ $T_2 = 717.65\ K$

$\frac{V_4}{V_3} = 13$, $\frac{V_1}{V_2} = 9$, $V_2 = V_3$

$\Rightarrow V_1/V_3 = 9$

$V_4/V_1 \Rightarrow V_4/V_3 \cdot V_1/V_3 = 13/9$

$\frac{V_4}{V_1} \cdot \frac{T_4}{T_4} \Rightarrow T_4 = \frac{13}{9}(298) = 1130.44\ K$

$T_3/T_4 = (V_4/V_3)^{k-1} \Rightarrow T_3 = 1200.87\ K$

b) $q_{in} = C_v [T_3 - T_2] =$ **346.76**

$q_{out} = C_p [T_4 - T_1] =$ **133.05**

$W = Q_{in} - Q_{out} =$ **213.71**

c) $\eta = 1 - \frac{Q_{out}}{Q_{in}} =$ **61.6**

$\eta_{otto} = 1 - \frac{1}{9^{k-1}} \Rightarrow$ **.566**

d) $MEP = \frac{w_{net}}{V_4 - V_1}$

$V_1 = \frac{RT_1}{P_1} \Rightarrow .855$

$V_4 = V_1 \cdot \frac{13}{9} = 1.235$

$\Rightarrow \boxed{MEP = 562.4\ kN/m^3}$

c)