a) \[ Q_{in} = 1200 \text{ kcal} \quad (50 \text{ or } 8000) \]
\[
\eta_c = 1 - \frac{T_c}{T_H} = 1 - \frac{300 \text{kcal}}{400 \text{kcal}} = 0.25
\]
\[ \eta_c = \frac{W_{net}}{Q_{in}} \quad \Rightarrow \quad W_{net} = \eta_c Q_{in} = (0.25)(1200 \text{kcal}) \]
\[ = 300 \text{ kcal} \]
\[ (Q_{out})_{net} + W_{net} = Q_{in} \quad \Rightarrow \quad (Q_{out})_{net} = Q_{in} - W_{net} = 900 \text{kcal} \]

b) \[ K_c = \frac{T_c}{T_H - T_c} = \frac{300}{400 - 300} = 3.0 \]
\[ K_c = \frac{Q_{cold}}{W_{net}} \quad \Rightarrow \quad W_{net} = \frac{Q_{cold}}{K_c} = \frac{1200 \text{kcal}}{3.0} = 400 \text{kcal} \]
\[ Q_H = 1200 \text{kcal} + 400 \text{kcal} = 1600 \text{kcal} \]
\[ (6.694 \text{ kcal}) \]

C) In a), engine did 300 kcal of work (net) \[ \text{see above} \]

In b), \[ 400 \text{kcal} \] of work was done on gas. \[ \text{see above} \]

d) Again, see above \[ \eta_i = 0.25 \]
\[ K_c = 3.0 \]