4.1) (a) The net work done by the gas is $\oint P\,dV$

$$= P_2 (V_2 - V_1) - P_1 (V_2 - V_1) = (\Delta P)(\Delta V) = 2P_1V_1 .$$

The heat input is now in 2 steps and adds up to $\frac{5}{2}(\Delta P) V_1 + \frac{7}{2} P_2 (\Delta V) = \frac{5}{2} P_1 V_1 + \frac{7}{2}(2P_1)(2V_1)$

$$= \left(\frac{5}{2} + 14\right) P_1 V_1 .$$

Thus, $\epsilon = \dfrac{2P_1V_1}{16.5\, P_1V_1} \simeq 12\%$.

(b) The max temperature is $\dfrac{P_2 V_2}{nR} = 6\dfrac{P_1V_1}{nR}$.

The min temperature is $\dfrac{P_1V_1}{nR}$.

Thus, a Carnot engine operated between these extremes has efficiency $\dfrac{6-1}{6} = \dfrac{5}{6} \cong 83\%$.