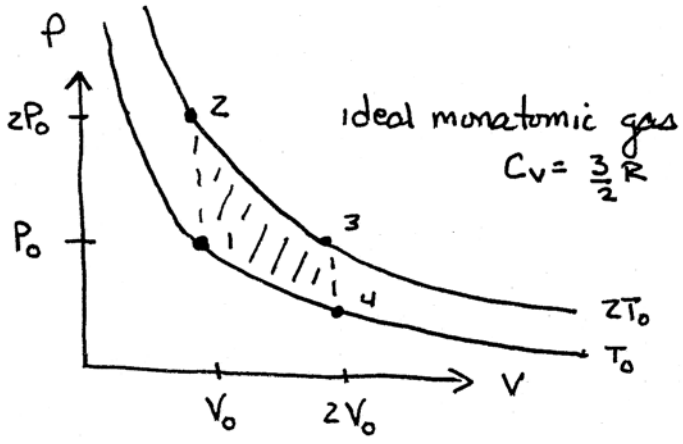
Stirling Engine



ideal monatomic gas

$C_V = \frac{3}{2}R$

$P_0V_0 = nRT_0$

$\Rightarrow nR = \frac{P_0V_0}{T_0}$

Q_{IN}: 1-2 isovolumetric temperature increase

$$Q_{12} = nC_V\Delta T = nR\frac{3}{2}\Delta T = \frac{P_0V_0}{T_0}\frac{3}{2}T_0 = \frac{3}{2}P_0V_0$$

2-3 isothermal expansion at $2T_0$

$$Q_{23} = W_{23} = nR(2T_0)\ln\frac{2V_0}{V_0} = \frac{P_0V_0}{T_0}2T_0\ln 2 = 2P_0V_0\ln 2$$

Q_{OUT}: 3-4 $= -\frac{3}{2}P_0V_0$

4-1 $= -P_0V_0\ln 2$

$$e = 1 - \frac{Q_{out}}{Q_{in}} = 1 - \frac{P_0V_0\left(\frac{3}{2}+\ln 2\right)}{P_0V_0\left(\frac{3}{2}+2\ln 2\right)} = 1 - \frac{2.193}{2.886} = .24$$

$$e_{CARNOT} = 1 - \frac{T_L}{T_H} = 1 - \frac{T_0}{2T_0} = .5$$