

Callen

② 4.2-2. (a) The isentropics of the gas is described by

$$\frac{dP}{T} = \frac{dS}{dV} = \frac{R}{V} \quad \frac{1}{T} = \frac{dS}{dU} = \frac{3}{2} R \frac{1}{U}$$

$$\Rightarrow S(V) = R \ln V, \quad S(U) = \frac{3}{2} R \ln U.$$

$$\Rightarrow S = R \ln [V U^{3/2}], \Rightarrow S \propto \ln [V T^{3/2}] \text{ since } V \propto T.$$

So the isentropics is characterized by  $V T^{3/2} = \text{constant}$ .

① adiabatic expansion  $T \downarrow$   $V \uparrow$ .

$$T_i = 400 \text{ K}, \quad V_i = 1 \text{ L}, \quad V T^{3/2} = 8000.$$

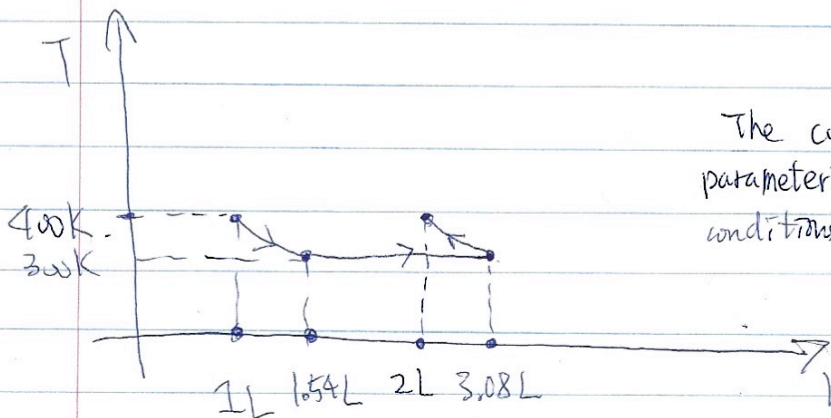
$$T_f = 300 \text{ K}, \quad T_f^{3/2} V_f = 8000, \quad V_f = 1.54 \text{ L}.$$

② isothermal expansion  $T =$   $V \uparrow$ .

③ adiabatic compression  $T \uparrow$   $V \downarrow$ .

$$T_f = 400 \text{ K}, \quad V_f = 2 \text{ L}, \quad V T^{3/2} = 16000.$$

$$T_i = 300 \text{ K}, \quad V_i = 16000 / (300)^{3/2} = 3.08 \text{ L}.$$



The curves are fully parameterized by the initial conditions and  $V T^{3/2} = \text{const.}$