

Isentropic Processes, $\Delta S = 0$

For **ideal gases**, with constant C_p & C_v

$$\Delta s = C_v \ln \frac{T_2}{T_1} + R \ln \frac{v_2}{v_1} = 0$$

$$C_v \ln \frac{T_2}{T_1} = -R \ln \frac{v_2}{v_1}$$

$$\ln \frac{T_2}{T_1} = -\frac{R}{C_v} \ln \frac{v_2}{v_1} = \ln \left(\frac{v_1}{v_2} \right)^{R/C_v}$$

$$\rightarrow \ln \frac{T_2}{T_1} = \ln \left(\frac{v_1}{v_2} \right)^{k-1}$$

$$\frac{T_2}{T_1} = \left(\frac{v_1}{v_2} \right)^{k-1}$$

$$C_p - C_v = R$$

$$k = \frac{C_p}{C_v}$$

$$\therefore \frac{R}{C_v} = k - 1$$

Another one

$$\Delta s = C_p \ln \frac{T_2}{T_1} - R \ln \frac{p_2}{p_1} = 0$$

$$\ln \frac{T_2}{T_1} = \frac{R}{C_p} \ln \frac{p_2}{p_1}$$

$$= \ln \left(\frac{p_2}{p_1} \right)^{R/C_p}$$

$$= \ln \left(\frac{p_2}{p_1} \right)^{\frac{k-1}{k}}$$

$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1} \right)^{\frac{k-1}{k}}$$

$$C_p - C_v = R$$

$$\frac{R}{C_p} = \frac{C_p}{C_p} - \frac{C_v}{C_p} = 1 - \frac{1}{k}$$

$$\therefore \frac{R}{C_p} = \frac{k-1}{k}$$

Combined to become

$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1} \right)^{\frac{k-1}{k}} = \left(\frac{v_1}{v_2} \right)^{k-1}$$

Ideal gas,
constant C_p , C_v