

1.

$$dU = \Theta ds - p dv$$

$$dh = du + v dp + p dv$$

$$dh = v dp - \cancel{p dv} = \Theta ds - \cancel{p dv}$$

$$ds = \frac{dh}{\Theta} - \frac{v}{\Theta} dp$$

2.

$$dU = \Theta ds - p dv$$

$$du = c_v d\Theta \quad p v = R \Theta \Rightarrow p = \frac{R \Theta}{v}$$

$$ds = \frac{c_v d\Theta}{\Theta} + \frac{R}{v} dv$$

$$s - s_0 = c_v \ln\left(\frac{\Theta}{\Theta_0}\right) + R \ln\left(\frac{v}{v_0}\right)$$

3.

$$dh = \Theta ds + v dp$$

$$dh = c_p d\Theta \quad p v = R \Theta \quad v = \frac{R \Theta}{p}$$

$$ds = \frac{c_p d\Theta}{\Theta} - R \frac{dp}{p}$$

$$s - s_0 = c_p \ln \frac{\Theta}{\Theta_0} - R \ln \frac{p}{p_0}$$

4.

(2)

$$0 = + \frac{R\theta}{C_V} \ln \frac{V}{V_0} + \frac{R\theta}{C_P} \ln \frac{p}{p_0}$$

$$0 = \frac{C_P}{C_V} \ln \frac{V}{V_0} + \ln \frac{p}{p_0}$$

$$0 = \ln \left(\frac{V}{V_0} \right)^n + \ln \frac{p}{p_0}$$

$$\frac{p}{p_0} \frac{V^n}{V_0^n} = 1$$

$$p V^n = p \frac{1}{p^n} = \frac{p_0}{p_0^n} = \text{const}$$

5.

$$h + \frac{u^2}{2} = \text{const}$$

$$u = 700 \text{ km/h} \quad \theta = 300 \text{ K} \quad p = 1 \text{ atm} \quad u = 194 \text{ m/s}$$

$$p_0? \quad C_P = 1000 \text{ J/kgK} \quad \text{isentrope} \quad \gamma = \frac{C_P}{C_V} = 1.4$$

$$C_P \theta_R = C_P \theta_1 + \frac{u_1^2}{2}$$

$$\theta_R = \theta_1 + \frac{1}{2C_P} u_1^2 \quad \Rightarrow \theta_R = 318.9 \text{ K}$$

$$\frac{p_R}{p} = \left(\frac{\theta_R}{\theta} \right)^{\frac{\gamma}{\gamma-1}} = 1.238$$

$$p_R = 1.238 \text{ atm.}$$

6.
$$\rho c_p \frac{D\theta}{Dt} - \beta \theta \frac{Dp}{Dt} = k \nabla^2 \theta + \sigma_{ij} e_{ij}$$

$$\beta = \frac{1}{V} \left. \frac{\partial \theta}{\partial p} \right|_p \quad \beta^* = \beta \theta_0$$

$$\frac{\rho_0 c_0 \theta_0 U_0}{l_0} \rho^* c_p^* \frac{D\theta^*}{Dt^*} - \frac{1}{\theta_0} \frac{\rho_0 U_0}{l_0} \beta^* \theta^* \frac{Dp^*}{Dt^*} =$$

$$= \frac{k_0 \theta_0}{l_0^2} k^* \nabla^{*2} \theta^* + \frac{\mu_0 U_0^2}{l_0^2} \sigma_{ij}^* e_{ij}^*$$

$$\rho^* c_p^* \frac{D\theta^*}{Dt^*} - A \beta^* \theta^* \frac{Dp^*}{Dt^*} = B k^* \nabla^{*2} \theta^* + C \sigma_{ij}^* e_{ij}^*$$

$$A = \frac{\rho_0 U_0}{l_0} \frac{l_0}{\rho_0 c_0 \theta_0 U_0} = \frac{\rho_0}{\rho_0 U_0^2} \frac{U_0^2 l_0}{\cancel{\rho_0} c_0 \theta_0} = \frac{1}{Ru} Ec$$

 incompressibile.

oppure

$$A = \frac{\rho_0 U_0}{l_0} \frac{l_0}{\rho_0 c_0 \theta_0 U_0} = \frac{Ri}{Co} \quad \text{compressibile}$$

$$B = \frac{k_0 \theta_0}{l_0^2} \frac{l_0}{\rho_0 c_0 \theta_0 U_0} \frac{\mu_0}{\mu_0} = \frac{1}{Pr} \frac{1}{Re}$$

$$C = \frac{\mu_0 U_0^2}{l_0^2} \frac{l_0}{\rho_0 c_0 \theta_0 U_0} = \frac{Ec}{Re}$$