

1) B3-3

$$(a) Gr = \frac{L^3 \rho g \Delta T}{\nu^2} = \frac{L^3 \rho g \Delta T \rho^2}{\mu^2} = \underline{4.23 \times 10^4}$$

$$(b) Nu = 0.53 (Gr \cdot Pr)^{1/4}$$

$$Pr = \frac{\mu C_p}{k} = 0.7$$

$$\therefore Nu = \underline{6.95}$$

$$(c) Q = hA\Delta T = h\pi d l \Delta T$$

$$Nu = \frac{hd}{k} \quad h = \frac{k}{d} Nu = 10.4$$

$$\therefore Q = 10.4 \times \pi d l = \underline{15.7}$$

$$2) (d) Re = \frac{\rho v D}{\mu} = \frac{0.9 \times 2 \times 0.02}{2 \times 10^{-5}} = \underline{1800}$$

$$(e) Nu = 0.26 Re^{0.6} Pr^{0.3} = 21$$

$$h = \frac{k}{d} Nu = \underline{31.5}$$

$$(f) \therefore Q = hA\Delta T = \underline{47.5}$$

$$(g) U^* \rightarrow U/U_0, V^* \rightarrow V/U_0, x^* \rightarrow x/L, y^* \rightarrow y/L, T^* \rightarrow \frac{T-T_0}{T_s-T_0}$$

(h) 位置 (無次元化)

$$\frac{\partial U}{\partial x} = \frac{\partial (U^* U_0)}{\partial (x^* L)} = \frac{\partial (U^* U_0)}{\partial U^*} \cdot \frac{\partial x^*}{\partial (x^* L)} \therefore \frac{\partial U^*}{\partial x^*} = \frac{U_0}{L} \frac{\partial U^*}{\partial x^*} \quad (y \text{ も同様})$$

$$\text{また, } \frac{\partial^2 U}{\partial y^2} = \frac{\partial}{\partial y} \left(\frac{\partial (U^* U_0)}{\partial (y^* L)} \right) = \frac{\partial}{\partial y} \left(\frac{U_0}{L} \frac{\partial U^*}{\partial y^*} \right) = \frac{U_0}{L} \frac{\partial}{\partial (y^* L)} \frac{\partial U^*}{\partial y^*} = \frac{U_0}{L^2} \frac{\partial^2 U^*}{\partial y^{*2}}$$

よって (4) 式を整理すると

$$\frac{U_0^2}{L} U^* \frac{\partial U^*}{\partial x^*} + \frac{U_0^2}{L} V^* \frac{\partial U^*}{\partial y^*} = \frac{U_0}{L^2} \nu \frac{\partial^2 U^*}{\partial y^{*2}} + \frac{g \rho L^3 (T_s - T_0)}{\nu^2} T^* \times \frac{\nu^2}{L^3}$$

$$U^* \frac{\partial U^*}{\partial x^*} + V^* \frac{\partial U^*}{\partial y^*} = \frac{\nu}{L U_0} \frac{\partial^2 U^*}{\partial y^{*2}} + Gr \cdot T^* \cdot \frac{\nu^2}{L^2 U_0^2}$$

$$\frac{\rho U D}{\mu} = \frac{2D}{\nu} = Re \quad (1)$$

$$A = Re^{-1}, \quad B = Gr \cdot Re^{-2}$$