$$\cancel{\frac{\partial \vec{u}}{\partial t} = -T_a\, \hat{z} \times \vec{u} - (\nabla \times \vec{u}) \times \vec{u} - (\nabla \times \vec{B}) \times \vec{B} - R_a \Theta \hat{r} - \nabla \Pi}$$

$$\rho_0 \left(\frac{\partial \vec{u}'}{\partial t'} + (\nabla' \times \vec{u}') \times \vec{u}' \right) = -2\rho_0 \Omega\, \hat{z} \times \vec{u}' - \frac{\nabla' P}{\rho_0} + \frac{\rho \vec{g}'}{\rho_0} + \frac{\vec{J}' \times \vec{B}'}{\rho_0} + \nu \nabla'^2 \vec{u}'$$

$$\boxed{\vec{u}' = \frac{\nu}{d} \vec{u}}$$

$$\boxed{\vec{r}' = d\, \vec{r}}$$

$$\boxed{t' = \frac{d^2}{\nu} t}$$

$$\vec{B}' = \frac{\nu}{d} \sqrt{\mu_0 \rho_0}$$

$$\frac{\nu^2}{d^3} \frac{\partial \vec{u}}{\partial t} + \frac{1}{d} \frac{\nu^2}{d^2} (\nabla \times \vec{u}) \times \vec{u} = \qquad \boxed{\rho = \rho_0 \alpha \Theta \Delta T,\ \vec{g}' = d\gamma \vec{r}}$$

$$= 2 \Omega \frac{\nu}{d}\, \hat{z} \times \vec{u} - \frac{\nabla P}{\rho_0 d} + \gamma \alpha \Theta r d \Delta T \hat{r} +$$

$$+ \frac{1}{d \mu_0 \rho_0} (\nabla \times \vec{B}') \times \vec{B}' + \frac{\nu^2}{d^3} \nabla^2 \vec{u}$$

$$\frac{\nu}{2\Omega d^2} \left(\frac{\partial \vec{u}}{\partial t} + (\nabla \times \vec{u}) \times \vec{u} \right) = \hat{z} \times \vec{u} - \nabla \Pi + \frac{\gamma \alpha d^2 \Delta T}{2\Omega \nu} \Theta \vec{r} + \frac{1}{2\rho_0 \Omega \nu \mu_0} (\nabla \times \vec{B}) \times \vec{B}' +$$

$$+ \frac{\nu^2 d}{d^3\, 2\Omega} \nabla^2 \vec{u}$$

$$\Rightarrow \left(\frac{\partial \vec{u}}{\partial t} + (\nabla \times \vec{u}) \times \vec{u} \right) = \tau \hat{z} \times \vec{u} - \nabla \Pi + \frac{\gamma \alpha d^4 \Delta T}{\nu^2} \Theta \vec{r} +$$

$$+ \quad (\nabla \times \vec{B}) \times \vec{B} + \nabla^2 \vec{u}$$

$$\Rightarrow \frac{\partial \vec{u}}{\partial t} + (\nabla \times \vec{u}) \times \vec{u} = \tau \hat{z} \times \vec{u} - \nabla \Pi + \frac{\gamma \alpha d^4 \Delta T}{\nu^2} \Theta \vec{r} + (\nabla \times \vec{B}) \times \vec{B} + \nabla^2 \vec{u}$$

$$\boxed{\Delta T = \beta d^2 \nu / \kappa}$$

$$\frac{\gamma \alpha d^4 \Delta T}{\nu^2} = \cancel{\frac{\gamma \alpha d^4 \Delta T}{\nu \kappa}} \left(\frac{\kappa}{\nu}\right) = \frac{R_a}{P_r} \qquad R_a = \frac{\gamma \alpha d^4 \Delta T}{\nu \kappa} = \frac{\gamma \alpha d^6 \beta}{\nu \kappa}$$