第九次作业

10.4, 10.5, 11.2, 11.5, 11.10

10.4

$$\therefore h = (L - R\varphi - R\tan\theta)\cos\theta$$

$$\therefore rac{\mathrm{d}L}{\mathrm{d}T} - rac{\mathrm{d}R}{\mathrm{d}T} \left(rac{\pi}{2} - heta + an heta
ight)$$

$$\therefore rac{\mathrm{d}L}{\mathrm{d}T} \equiv Llpha_{\mathrm{steel}}, rac{\mathrm{d}R}{\mathrm{d}T} \equiv Rlpha_{\mathrm{Al}}$$

$$\therefore Llpha_{ ext{steel}} - Rlpha_{ ext{Al}}\left(rac{\pi}{2} - heta + an heta
ight) = 0$$

$$\therefore R = rac{2L}{\pi - 2 heta + 2 heta} rac{lpha_{
m steel}}{lpha_{
m Al}} pprox 0.63 {
m m}$$

10.5

$$\therefore a^2 x
ho_{
m Hg} g = a^3
ho_{
m Al} g, x = a rac{
ho_{
m Al}}{
ho_{
m Hg}} = 3.97 {
m ~cm}$$

同时我们有

$$\ln x = \ln a + \ln
ho_{
m Al} - \ln
ho_{
m Hg}$$

$$\frac{\mathrm{d}\ln x}{\mathrm{d}T} = \frac{1}{a}\frac{\mathrm{d}a}{\mathrm{d}T} + \frac{1}{\rho_{\mathrm{Al}}}\frac{\mathrm{d}\rho_{\mathrm{Al}}}{\mathrm{d}T} - \frac{1}{\rho_{\mathrm{Hg}}}\frac{\mathrm{d}\rho_{\mathrm{Hg}}}{\mathrm{d}T}$$

$$\therefore \frac{1}{\rho_{\mathrm{Al}}} \frac{\mathrm{d}\rho_{\mathrm{Al}}}{\mathrm{d}T} = \frac{V}{m} \frac{\mathrm{d}}{\mathrm{d}T} \left(\frac{m}{V} \right) = V \left(-\frac{1}{V^2} \right) \frac{\mathrm{d}V}{\mathrm{d}T} = -\frac{1}{V} \frac{\mathrm{d}v}{\mathrm{d}t} = -\beta$$

$$\therefore \int \mathrm{d} \ln x = \int \mathrm{d} T (lpha_{
m Al} - eta_{
m Al} + eta_{
m Hg}) = (lpha_{
m Al} - eta_{
m Al} + eta_{
m Hg}) \int \mathrm{d} T$$

$$\therefore \ln rac{x}{x_0} (lpha_{
m Al} - eta_{
m Al} + eta_{
m Hg}) \Delta T = 6.7 imes 10^{-3}$$

$$\therefore \Delta x = x_0 (e^{6.7 imes 10^{-3}} - 1) = x_0 imes 6.7 imes 10^{-3} = 0.27 ext{ mm}$$

11.2

$$\because p = rac{AT^3}{V}, U = BT^n \ln \left(rac{V}{V_0}
ight) + f(T)$$

由书中 P.213 页可得到方程

$$\left(\frac{\partial U}{\partial V}\right)_T = T \left(\frac{\partial p}{\partial T}\right)_V - p$$

则可得

$$\frac{BT^n}{V} = \frac{T \cdot 3AT^2}{V} - \frac{AT^3}{V}$$

解得

$$n = 3, B = 2A$$

11.5

$$\because p_1 = p_0 + rac{mg}{A}$$

 $\therefore pV^{\gamma}$ 为常量

$$\therefore \frac{\mathrm{d}p}{p} = -\gamma \frac{\mathrm{d}V}{V} = -\gamma \frac{Ax}{V_0}$$

$$\therefore f = \mathrm{d} p \cdot A = -\gamma rac{pA^2}{V_0} x$$

$$\therefore \omega^2 = rac{\gamma A^2 p}{m V_0}, v = rac{\omega}{2\pi}$$

11.10

$$\eta=1-\left(rac{V_1}{v_2}
ight)^{\gamma-1}=1-\left(rac{V_1}{v_2}
ight)^{rac{2}{5}}$$