Homework 7

1 Problem 1:

The total mass of the Earth's atmosphere is:

$$M = \frac{4\pi R^2 P}{g} = 5.27 \times 10^{18}\text{kg} \tag{1}$$

2 Problem 2:

The force on the bottom is:

$$F_b = \rho g h \cdot s = 6 \times 10^6\text{N} \tag{2}$$

The force on each end is:

$$F_e = \int_0^2 \rho g h 10 \mathrm{d}h = 2 \times 10^5\text{N} \tag{3}$$

The force on each side is

$$F_s = \int_0^2 \rho g h 30 \mathrm{d}h = 6 \times 10^5\text{N} \tag{4}$$

3 Problem 3:

According to the Bernoulli equation and continuity equation,we find:

$$P_1 + \tfrac{1}{2}\rho_1 v_1^2 = P_2 + \tfrac{1}{2}\rho_2 v_2^2 \tag{5}$$

$$\pi r_1^2 v_1 = \pi r_2^2 v_2 \tag{6}$$

and:

$$\rho_1 = \rho_2 = 700\text{kg/m}^3 \tag{7}$$

therefore:

$$v_1 = 2m/s, v_2 = 8m/s \tag{8}$$

and the fluid flow rate is:

$$Q = \pi r_1^2 v_1 = 2.5 \times 10^{-3} \mathrm{m}^3/\mathrm{s} \tag{9}$$

4 Problem 4:

According to the Bernoulli equation and continuity equation,we find:

$$P_1 + \frac{1}{2}\rho_1 v_1^2 = P_2 + \frac{1}{2}\rho_2 v_2^2 \tag{10}$$

and:

$$P_2 - P_1 = \rho_{\mathrm{Hg}} g \Delta h = \frac{1}{2}\rho_1 v_1^2 \tag{11}$$

thus:

$$v_1 = \sqrt{\frac{2\rho_{hg} \cdot g\Delta h}{\rho_1}} = 104.3\mathrm{m/s} \tag{12}$$

5 Problem 5:

We find:

$$\rho_{\mathrm{w}} g(h_1 + h_2) = \rho_{\mathrm{Hg}} \cdot g \cdot h_2 \tag{13}$$

thus:

$$h_1 = 0.126\mathrm{m} \tag{14}$$