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For water at 20°C, we could just look it up in Table A-3, but we more usefully try to estimate B from the state relation (1-22). Thus, for a liquid, approximately,

$$B = \rho \frac{d}{d\rho} [p_o \{ (B+1)(\rho/\rho_o)^n - B \}] = n(B+1)p_o (\rho/\rho_o)^n = n(B+1)p_o \quad \text{at 1 atm}$$

For water,  $B = 3000$  and  $n = 7$ , so our estimate is

$$B_{\text{water}} = 7(3001)p_o = 21007 \text{ atm} = \mathbf{2.13E9 \text{ Pa}} \quad \text{Ans. (b)}$$

This is 2.7% less than the value  $B = 2.19E9 \text{ Pa}$  listed in Table A-3.

**1.37** A near-ideal gas has  $M = 44$  and  $c_v = 610 \text{ J/(kg}\cdot\text{K)}$ . At 100°C, what are (a) its specific heat ratio, and (b) its speed of sound?

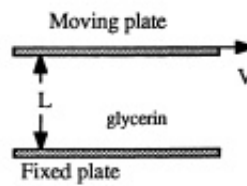
**Solution:** The gas constant is  $R = A/M = 8314/44 = 189 \text{ J/(kg}\cdot\text{K)}$ . Then

$$c_v = R/(k-1), \quad \text{or:} \quad k = 1 + R/c_v = 1 + 189/610 = \mathbf{1.31} \quad \text{Ans. (a)} \quad [\text{It is probably } \text{N}_2\text{O}]$$

With  $k$  and  $R$  known, the speed of sound at 100°C = 373 K is estimated by

$$a = \sqrt{kRT} = \sqrt{1.31[189 \text{ m}^2/(\text{s}^2 \cdot \text{K})](373 \text{ K})} = \mathbf{304 \text{ m/s}} \quad \text{Ans. (b)}$$

**1.38** In Fig. P1.38, if the fluid is glycerin at 20°C and the width between plates is 6 mm, what shear stress (in Pa) is required to move the upper plate at  $V = 5.5 \text{ m/s}$ ? What is the flow Reynolds number if “ $L$ ” is taken to be the distance between plates?



**Fig. P1.38**

**Solution:** (a) For glycerin at 20°C, from Table 1.4,  $\mu = 1.5 \text{ N}\cdot\text{s/m}^2$ . The shear stress is found from Eq. (1) of Ex. 1.8:

$$\tau = \frac{\mu V}{h} = \frac{(1.5 \text{ Pa}\cdot\text{s})(5.5 \text{ m/s})}{(0.006 \text{ m})} = \mathbf{1380 \text{ Pa}} \quad \text{Ans. (a)}$$

The density of glycerin at 20°C is  $1264 \text{ kg/m}^3$ . Then the Reynolds number is defined by Eq. (1.24), with  $L = h$ , and is found to be decidedly laminar,  $Re < 1500$ :

$$Re_L = \frac{\rho VL}{\mu} = \frac{(1264 \text{ kg/m}^3)(5.5 \text{ m/s})(0.006 \text{ m})}{1.5 \text{ kg/m}\cdot\text{s}} = \mathbf{28} \quad \text{Ans. (b)}$$



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