Homework 6

Total 13.5

Ch 9: 40: $V = 1.5\,m \cdot 0.60\,m \cdot 0.40\,m = 0.36\,m^3$

$\frac{\Delta V}{\Delta t} = A \cdot v = \frac{\pi}{4} d^2 \cdot v = \frac{\pi}{4} (0.020\,m)^2 \cdot 1.5 \frac{m}{s} = 4.7 \cdot 10^{-4} \frac{m^3}{s}$

$t \cdot \frac{\Delta V}{\Delta t} = V$

$\rightarrow t = \frac{V}{\frac{\Delta V}{\Delta t}} = 764\,s = 13\,min.$ (0.5)

41: (a) $\frac{\Delta m}{\Delta t} = \rho \frac{\Delta V}{\Delta t} = \rho \cdot A \cdot v = 1.0 \frac{g}{cm^3} \cdot 2.0\,cm^2 \cdot 40 \frac{cm}{s} = 80 \frac{g}{s}$ (1)

(b) $A_1 v_1 = A_2 v_2$

$\rightarrow v_2 = \frac{A_1}{A_2} v_1 = \frac{2.0\,cm^2}{3.0 \cdot 10^3\,cm^2} \cdot 40\,cm/s = 0.027 \frac{cm}{s}$

43. $p_1 = p_{Atm} + \frac{F}{A_1}$ $\quad v_1 = 0$ (1)

$p_2 = p_{Atm}$

$p_1 + \frac{1}{2} \rho v_1^2 = p_2 + \frac{1}{2} \rho v_2^2$

$v_2^2 = \frac{2}{\rho}(p_1 - p_2) = \frac{2}{\rho} \frac{F}{A_1} = \frac{2 \cdot 2.00\,N}{1.00 \cdot 10^3 \frac{kg}{m^3} \cdot 2.50 \cdot 10^{-5}\,m^2} = 160 \frac{m^2}{s^2}$

$v_2 = 12.6 \frac{m}{s}$

46. (a) (1)

$p_1 + \frac{1}{2} \rho v_1^2 + \rho g h_1 = p_2 + \frac{1}{2} \rho v_2^2 + \rho g h_2$

$p_{Atm} + 0 + \rho g h_1 = p_{Atm} + \frac{1}{2} \rho v_2^2 + 0$

$\rightarrow v_2^2 = 2 g h_1 = 2 \cdot 9.80 \frac{m}{s^2} \cdot 16.0\,m \quad \rightarrow v_2 = 17.7 \frac{m}{s}$

(b) $\frac{\Delta V}{\Delta t} = A v$

$\rightarrow A = \frac{\frac{\Delta V}{\Delta t}}{v} = \frac{2.50 \cdot 10^{-5} \frac{m^3}{min}}{17.7 \frac{m}{s}} = 2.35 \cdot 10^{-6}\,m^2 = 2.35\,mm^2$

$A = \frac{\pi}{4} d^2 \quad \rightarrow \quad d = \sqrt{\frac{4A}{\pi}} = 1.73\,mm$

48. (a) $p_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$ (1.5)

$p_1 + 0 + \rho g h_1 = p_{atm} + 0 + \rho g h_2$

$\rightarrow p_1 = p_{atm} + \rho g (h_2 - h_1) = 1.013 \cdot 10^5 Pa + 1.0 \cdot 10^3 \frac{kg}{m^3} \cdot 9.80 \cdot \frac{m}{s^2} (2096 m - 564 m)$

$= 1.51 \cdot 10^7 Pa = \underline{149 \text{ atm}}$

(b) $\frac{\Delta V}{\Delta t} = \frac{\pi}{4} d^2 \cdot v$

$\rightarrow v = \frac{4500 m^3 \cdot 4}{24 \cdot 3600 s \cdot \pi \cdot (0.150 m)^2} = \underline{2.95 \frac{m}{s}}$

(c) $p_1' + 0 + \rho g h_1 = p_{atm} + \frac{1}{2}\rho v_2^2 + \rho g h_2$

$\rightarrow p_1' = p_{atm} + \frac{1}{2}\rho v_2^2 + \rho g (h_2 - h_1)$

$p_1' - p_1 = \frac{1}{2}\rho v_2^2 = \underline{4.34 \cdot 10^3 Pa}.$

51. (a) $p_{atm} + \frac{1}{2}\rho \cdot 0^2 + \rho g h = p_{atm} + \frac{1}{2}\rho v^2 + 0$ (1)

$\rightarrow v = \sqrt{2gh}$

(b) $p_{atm} + \frac{1}{2}\rho \cdot 0^2 + \rho g h = 0 + \frac{1}{2}\rho \cdot 0^2 + \rho g (h + y)$

$p_{atm} = \rho g y$

$y = \frac{p_{atm}}{\rho g} = 10.3 m$

81.

$$P_1 + \tfrac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \tfrac{1}{2}\rho v_2^2 + \rho g h_2$$

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$$P_{atm} + \tfrac{1}{2}\rho \cdot 0^2 + \rho g h = P_{atm} + \tfrac{1}{2}\rho v_2^2 + \rho g L \cdot \sin\theta$$

$$\rho g h = \tfrac{1}{2}\rho v_2^2 + \rho g L \sin\theta$$

$$v_2^2 = 2g(h - L\sin\theta)$$

$$0 = (v_2 \sin\theta)^2 - 2 g h_m$$

$$h_m = \frac{v_2^2 \sin^2\theta}{2g} = \frac{2g(h - L\sin\theta)\sin^2\theta}{2g} = (h - L\sin\theta)\sin^2\theta$$

$$= (10.0\,m - 2.00\,m \cdot \tfrac{1}{2}) \cdot \tfrac{1}{4} = \underline{\underline{2.25\,m}}$$

Ch 10:

31. $p_1 V_1 = n_1 R T_1$

$p_2 V_2 = n_2 R T_2$ (1)

$V_1 = V_2$

$\rightarrow \frac{n_1 T_1}{p_1} = \frac{n_2 T_2}{p_2}$

$n_2 = \frac{1}{2} n_1$

$\frac{T_1}{p_1} = \frac{T_2}{2 p_2}$

$\rightarrow p_2 = \frac{T_2}{2T_1} p_1 = \frac{(65.0+273.2)k}{2(15.0+273.2)k} \cdot 10.0\,atm = \underline{\underline{5.87\,atm}}$

33. $pV = nRT$

$n_1 = n_2$

$\rightarrow \frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$ (1)

$\frac{p_1 \frac{4\pi}{3} \cdot r_1^3}{T_1} = \frac{p_2 \frac{4\pi}{3} r_2^3}{T_2}$

$\rightarrow r_2^3 = \frac{p_1 T_2}{p_2 T_1} r_1^3 = \frac{0.030\,atm}{1\,atm} \frac{300k}{200k} \cdot (20\,m)^3$

$\rightarrow r_2 = 7.11\,m \approx \underline{\underline{7.1\,m}}$

35. $pV = nRT$

$nRT = const$ (1)

$\rightarrow p_1 V_1 = p_2 V_2$

$p_2 = p_{atm}$

$p_1 = p_{atm} + \rho g h$

$V_1 = 1.50\,cm^3$

$V_2 = \frac{p_1}{p_2} V_1 = \frac{1.013 \cdot 10^5 Pa + 1000 \frac{kg}{m^3} \cdot 9.8 \frac{m}{s^2} \cdot 100\,m}{1.013 \cdot 10^5 Pa} \cdot 1.50 cm^3 = \underline{\underline{16.0\,cm^3}}$

47. $m_{CO_2} = 6.50\,g$

$\rightarrow n_{CO_2} = \frac{6.50\,g}{44 \cdot 10^{-3}\,\frac{kg}{mol}} = 0.148\,mol.$ (1)

$pV = nRT$

$V = \frac{nRT}{p} = \frac{0.148\,mol \cdot 8.312\,\frac{J}{mol\,K} \cdot 293.2\,K}{1.013 \cdot 10^5\,Pa} = 3.56 \cdot 10^{-3}\,m^3 = \underline{\underline{3.56\,l}}.$

54. (a) $pV = nRT$

$\frac{p_1}{T_1} = \frac{p_2}{T_2}$ (1)

$T_2 = \frac{p_2}{p_1} T_1 = \frac{3.20\,atm}{2.80\,atm} \cdot 300K = \underline{\underline{343\,K}}$

(b) $\frac{p_2}{n_2} = \frac{p_3}{n_3}$

$\rightarrow n_3 = \frac{p_3}{p_2} n_2$

$\frac{n_2 - n_3}{n_2} = 1 - \frac{p_3}{p_2} = 1 - \frac{2.80}{3.20} = 0.125 = \underline{\underline{12.5\%}}$

59. $pV = nRT$

$\rightarrow p_1 V_1 = p_2 V_2$ (1)

$p_1 = 0.95 \cdot p_{atm}$

$p_2 = 0.95 \cdot (p_{atm} + \rho \cdot g \cdot h)$

$\rightarrow p_{atm} V_1 = (p_{atm} + \rho \cdot g \cdot h) V_2$

$V_2 = \frac{p_{atm}}{p_{atm} + \rho \cdot g h} V_1 = \frac{1.013 \cdot 10^5\,Pa}{1.013 \cdot 10^5\,Pa + 1000\,\frac{kg}{m^3} \cdot 9.8\,\frac{m}{s^2} \cdot 10.0\,m} \cdot 0.820\,l = \underline{\underline{0.417\,l}}$

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