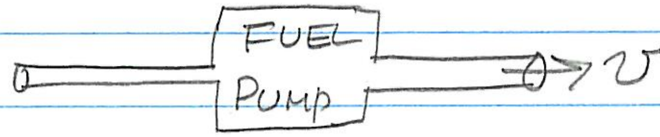
Chapter 11 (Part 2)

11-54



$$\frac{\Delta m}{\Delta t} = 5.88 \times 10^{-2}\ kg/s = \rho Q$$

$$= \rho v A$$

$$v = \frac{5.88 \times 10^{-2}}{\rho \pi r^2}$$

$$= \frac{5.88 \times 10^{-2}\ kg/s}{735\ kg/m^3 \times \pi (3.18 \times 10^{-3}\ m)^2}$$

$$= 2.52\ m/s$$

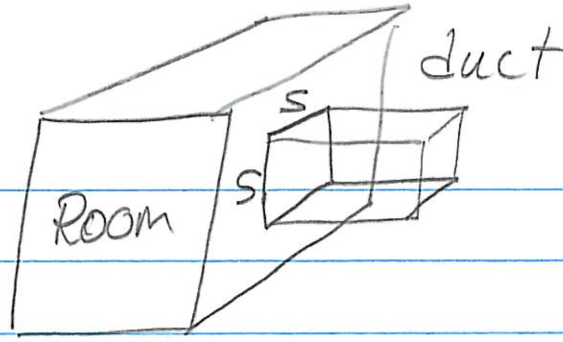
11-55

$$Q = \frac{9.5 \times 10^{-4}\ m^3}{6\ hrs \times 3600\ s/hr} = 4.4 \times 10^{-8}\ m^3/s$$

$$\frac{\Delta M}{\Delta t} = \rho Q = 1030\ \frac{kg}{m^3} \times 4.4 \times 10^{-8}\ m^3/s$$

$$= 4.5 \times 10^{-5}\ kg/s$$

11-57



$V = 120\,m^3$

$$Q = \frac{120\,m^3}{20 \times 60} = 0.1\,m^3/s$$

$$Q = v A$$

(a) $v = 3\,m/s$

$$0.1 = 3A = 3s^2$$

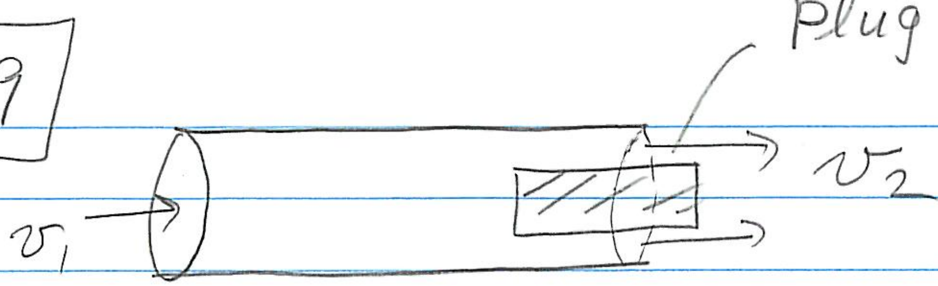
$$s = 0.18\,m$$

(b) $v = 5\,m/s$

$$0.1 = 5s^2$$

$$s = 0.14\,m$$

11-59



$Q_{in} = Q_{out}$

$v_1 A_1 = v_2 A_2$, $v_2 = 3v_1$

$v_1 A_1 = 3 v_1 A_2$, A_2 is the open area

$A_2 / A_1 = \frac{1}{3}$

$A_2 = A_1 - A_{plug} = \pi r_1^2 - \pi r_p^2$

$$\frac{\pi r_1^2 - \pi r_p^2}{\pi r_1^2} = \frac{1}{3}$$

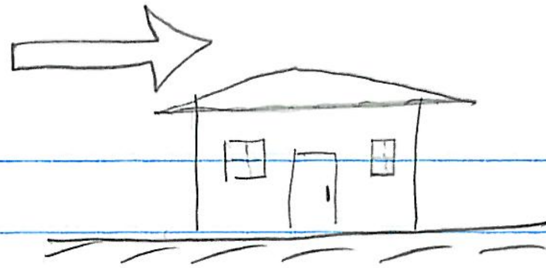
$3(r_1^2 - r_p^2) = r_1^2$, divide by r_1^2

$3(1 - r_p^2/r_1^2) = 1$

$3 - 3(r_p/r_1)^2 = 1$

$3(r_p/r_1)^2 = 2 \Rightarrow (r_p/r_1)^2 = \frac{2}{3}$, $r_p = 0.82 r_1$

11-61



(a) When there is NO wind $P = P_{atm}$

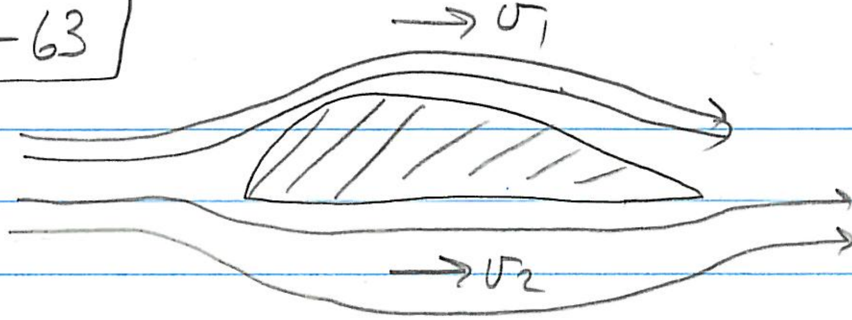
with wind : $P' + \frac{1}{2}\rho v^2$ so P' is lower than P_{atm} by

$$\frac{1}{2}\rho v^2 = \frac{1}{2}(1.29\ kg/m^3)(15)^2$$

$$= 145\ Pa$$

(b) The pressure outside the house is reduced below Patm, but the pressure inside the house is Patm, so there is an OUTWARD force on the walls & roof.

11-63



$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

$$P_1 + \frac{1}{2}(1.29)(251)^2 = P_2 + \frac{1}{2}(1.29)(225)^2$$

$$P_1 + 4.1\times10^4\ Pa = P_2 + 3.3\times10^4\ Pa$$

$$\Delta P = P_2 - P_1 = 8.3\times10^3\ Pa$$

$$F_{LIFT} = \Delta P \cdot A_{wing}$$

$$= 8.3\times10^3\ Pa \times 24\ m^2$$

$$= \underline{2\times10^5\ N}$$

11-69

(a) $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$

$Q_2 = Q_1$

$v_1 A_1 = v_2 A_2$

$P_2 - P_1 = \quad = \frac{1}{2}\rho v_1^2 - \frac{1}{2}\rho v_2^2$

$120\,Pa = \frac{1}{2}\rho\left(v_1^2 - v_2^2\right)$

$= \frac{1}{2}\rho\left[\left(\frac{A_2}{A_1}v_2\right)^2 - v_2^2\right]$

$= \frac{1}{2}\rho\left[\left(A_2/A_1\right)^2 - 1\right]v_2^2$

$A_2/A_1 = 0.07/0.05$

$120 = \frac{1}{2}(1.3)\left[(7/5)^2 - 1\right]v_2^2$

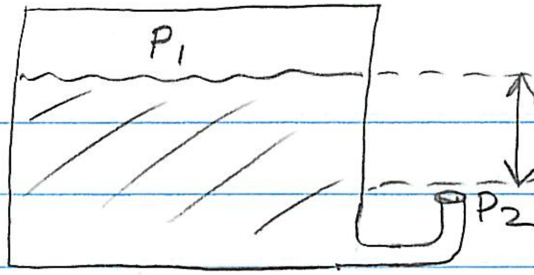
$= 0.62\,v_2^2$

$\Longrightarrow$ $v_2 = 13.9\ m/s$

(b) $Q = v_2 A_2 = 13.9 \times 0.07 = 0.97\ m^3/s.$

11-71

$P_1 = 6.01 \times 10^5$ Pa



$P_2 = P_{atm} = 1.01 \times 10^5$ Pa

(a) Since the tank is very large, as water leaves the nozzle (at speed v_2) the water level in the tank falls very slowly, so $v_1 \approx 0$. Then applying Bernoulli's equation between points ① and ② (take $y_2 = 0$)

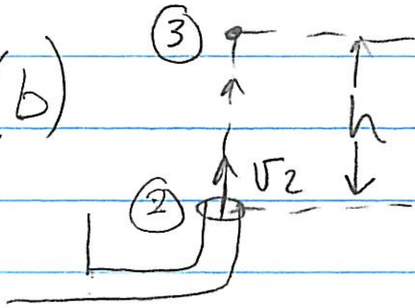
$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

$$6.01 \times 10^5 + 0 + (10^3 \text{kg/m}^3)(9.8)(4\text{m}) = 1.01 \times 10^5 + \frac{1}{2} \cdot 10^3 v_2^2 + 0$$

$$6.01 \times 10^5 + 3.9 \times 10^4 = 1.01 \times 10^5 + 500 v_2^2$$

$$5.39 \times 10^5 = 500 v_2^2 \Rightarrow \underline{v_2 = 32.8 \text{ m/s}}$$

(b)



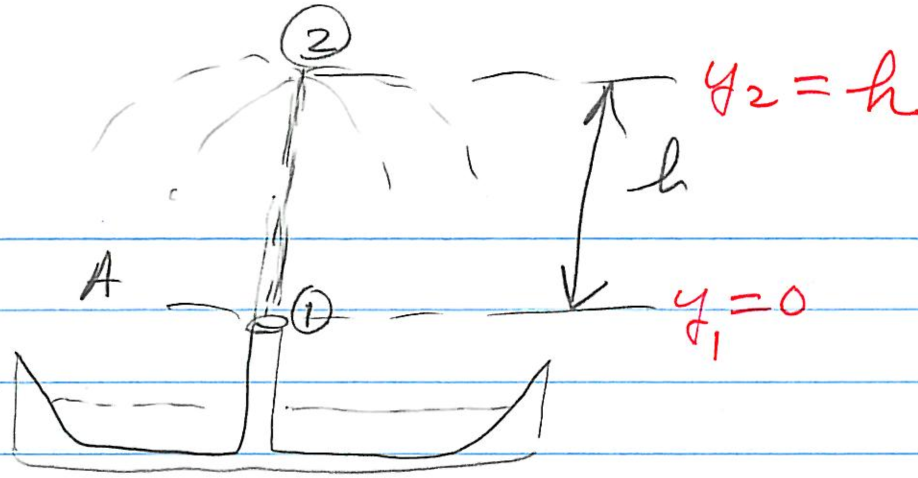
Apply Bernoulli's equation again, between points ② and ③, with $y_3 = h$ and $P_2 = P_3 = P_{atm}$, $v_3 = 0$

$$\cancel{P_{atm}} + \frac{1}{2}\rho v_2^2 + \rho g y_2 = \cancel{P_{atm}} + \frac{1}{2}\rho v_3^2 + \rho g h$$

$$\frac{1}{2}\cancel{\rho} v_2^2 + 0 = 0 + \cancel{\rho} g h$$

$$h = \frac{v_2^2}{2g} = \frac{(32.8 \text{m/s})^2}{2 \times 9.8} \simeq \underline{55 \text{ m}}$$

11-101



$A = 5 \times 10^{-4}\, m^2$, $h = 5\, m$

Apply Bernoulli's equation between points ① and ② , noting that $P_1 = P_2 \simeq P_{atm}$

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h$$

$$\frac{1}{2}\rho v_1^2 = 0 + \rho g h$$

$$v_1 = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 5\, m}$$

$$v_1 = 9.9\, m/s$$

$$Q = vA = 4.9 \times 10^{-3}\, m^3/s$$

Convert. $= 4.9 \times 10^{-3} \frac{m^3}{SEC} \times \frac{1\, gal}{3.79 \times 10^{-3}\, m^3} \times \frac{60 s}{min}$

$= 78\ gal/min$