4) GIVEN

$D = 10''$ $D_{o_1} = 1''$ $D_{o_2} = 7''$

$Q = 25\ gal/min$ $Sg_A = 0.83$ $m_A = 2.5 \times 10^{-6}$

A) $Q = \frac{25}{449} = 0.056\ Ft/s$ $A = \frac{\pi D^2}{4} = \frac{\pi (0.83)^2}{4} = 0.541^2$

$A_1 = \frac{\pi (0.083)^2}{4} = 0.00541\ Ft^2$ $A_2 = \frac{\pi (.583)^2}{4} = 0.267$

$\gamma = 0.83 \cdot 62.4 = 51.792$

$Q = C_{A_1} \sqrt{\frac{2gh(\gamma_m - \gamma_A) - 1}{\left(\frac{A_1}{A_2}\right)^2 - 1}} \Rightarrow h = \frac{\left(\frac{Q}{CA_1}\right)^2 \cdot \left(\left(\frac{A_1}{A_2}\right)^2 - 1\right)}{2g\left(\frac{\gamma_m}{\gamma_A} - 1\right)}$

$V = \frac{0.056}{0.541} = 0.1035\ Ft/s$

$\rho = Sg_A$ $\rho_w = 0.83 \cdot 1.94 = 1.6102$

$\gamma = \frac{m}{\rho} = \frac{2.5 \times 10^{-6}}{1.6102} = 1.553 \times 10^{-2}$ $N_R = \frac{VD}{\gamma}$

$N_R = \frac{.1035(.83)}{1.553 \times 10^{-2}} = 5531.5.518$ $C = 0.544$

$h = \frac{\left(\frac{0.056}{544 \cdot 541}\right)^2 \cdot \left(\frac{.541}{0.00541}\right)^2 - 1}{64.4\left(\frac{62.4}{51.792}\right) - 1} = \boxed{23.021 ft}$

B) $\frac{d}{D} = \frac{7}{10} = 0.7$ $C = 0.618$

$h = \frac{\left(\frac{0.056}{.618 \cdot .541}\right)^2 \cdot \left(\left(\frac{.541}{.267}\right)^2 - 1\right)}{64.4\left(\frac{62.4}{51.792}\right) - 1} = \boxed{0.0066'}$

9) given: $D_1 = 5''$ $T = 77°F$ $h = 8''$ $A_1 = 0.1259 ft^2$

$Q = 700 gpm \rightarrow 1000 gpm$ $\nu_{68} = 3.84 \times 10^{-4}$

$\gamma_m = 58 \ lb/ft^3$

$\gamma_{Hg} = 844.9$

$$A_1 = \frac{A}{\sqrt{\frac{2gh\left(\frac{\gamma_m}{\gamma_H} - 1\right)}{\left(\frac{Q}{A \cdot c}\right)^2 + 1}}}$$

$$= \frac{0.1259}{\sqrt{\frac{64.4(0.667)\left(\frac{844.9}{58}\right) - 1}{\left(\frac{2.227}{.1259 \cdot .96}\right)^2 + 1}}} = 0.074 ft^2$$

$$D = \sqrt{\frac{A \cdot 4}{\pi}} = \sqrt{\frac{.079 \cdot 4}{\pi}}$$

$D = 0.307'$

15) given: $T = 80°F$ $h = 0.24''$ $\gamma_{air} = 0.0736 \ lb/ft^3$

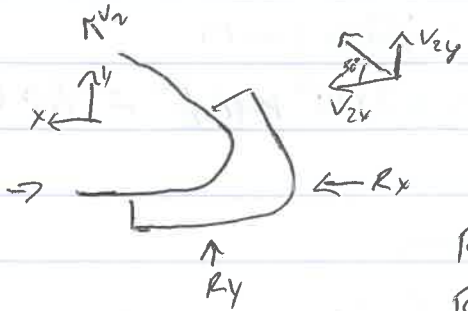
$\gamma_w = 62.4 \ lb/ft^3$

$V_1 = \sqrt{2gh(\gamma_w - \gamma_{air})/\gamma}$

$= \sqrt{64.4 \cdot (0.02) \cdot (62.4 - 0.0736)/0.0736}$

$V_1 = 33.026 \ ft/s$

16.6)



$Q = AV = (2.95\ in^2)(22.0\ Ft/s)(1\ Ft^2/144\ in)$

$Q = 0.451\ Ft^3/s$

$R_x = \rho Q(V_2 - V_1) = \rho Q[V_2\cos 50 - (-V_1)]$

$R_x = \rho Q[V_2\cos 50 + V_1)\ ;\ V_2 = V_1$

$R_x = \rho Q V_1[\cos 50 + 1]$

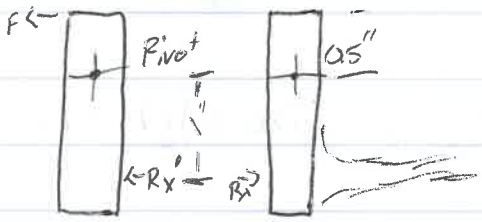
$R_x = \left(\frac{1.88\ lb\cdot s^2}{Ft^4}\right)\left(\frac{0.451\ Ft^3}{s}\right)\left(\frac{22.0\ Ft}{s}\right)(1.643)$

$\boxed{R_x = 30.6\ lb}$

$R_y = \rho Q[V_2 - V_1) \Rightarrow \rho Q[V_2\sin 50 - 0] = (1.88)(0.451)(22\sin 50)$

$\boxed{R_y = 14.5\ lb}$

16.11)



$Q = 100\ gal/min\left(\frac{1\ Ft^3/s}{449\ gal/min}\right) = 0.223\ Ft^3/s$

$V_1 = \frac{Q}{A} = \frac{0.223}{0.0060} = 37.1\ Ft/s$

$R_x = \rho Q(V_2 - V_1) = \rho Q[0 + V_1) = (\rho Q V_1)$

$R_x = \left(\frac{1.94\ lb\cdot s^2}{Ft^4}\right)\left(\frac{0.223\ Ft^3}{s}\right)\left(\frac{37.1\ Ft}{s}\right) = 16\ lb$

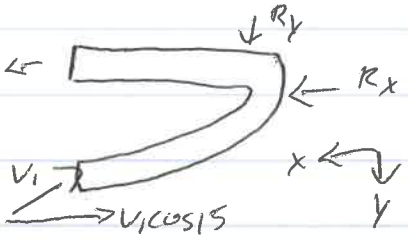
$R_x = R_x'$ $\quad \Sigma m_A = 0 \Rightarrow F_s(0.5) - R_x'(1.0)$

$F_s = R_x\left(\frac{1.0}{0.5}\right) = 2R_x' = 2(16\ lb) = \boxed{32.0\ lb}$

16.20)

$Q = AV = (3.142\times10^{-2})(30)$

$= 0.942\ m^3/s$



A) $R_x = \rho Q(V_2 - V_1) = \rho Q(V_2 - (-V_1\cos 15))$

$R_x = \rho Q V(1 + \cos 15) = 1.966\rho Q V$

$R_x = (1.966)\left(\frac{1000\ kg}{m^3}\right)\left(\frac{0.943\ m^3}{s}\right)\left(\frac{30\ m}{s}\right) = 55.6\ kN$

$R_y = \rho Q(v_2 - v_1) = \rho Q(0 - (-v_1 \sin 15)) = \rho Q v \sin 15$

$R_y = (1000)(0.943)(30)(0.259) = 7.32 \times 10^3 \text{ kg/m/s}^2 = 7.32 \text{ kN}$

b) $v_{1x} = v_1 \cos(15) = 30 \text{ m/s}(0.966) = 28.96 \text{ m/s}$

$v_{1y} = v_1 \sin(15) = 30 \text{ m/s}(0.259) = 7.76 \text{ m/s}$

$v_{e1x} = v_{1x} - 12 \text{ m/s} = 16.98 \text{ m/s}$

$v_{e1y} = \sqrt{16.98^2 + 7.76^2} = 18.67 \text{ m/s}$

$m_e = \rho q_e = \rho A v_{e1} = (1000)(3.142 \times 10^{-2})(18.67) = 586.6 \text{ kg/s}$

$\alpha = \tan^{-1}(7.76)/(16.98) = 24.58^\circ$

$\beta = 24.58^\circ - 15^\circ = 9.58^\circ$

$v_{e1par} = (v_{e1}) \cos(9.58) = (18.67)(0.986) = 18.41 \text{ m/s}$

force in x

$R_x = m_e(\Delta v_{ex}) = m_e(v_{e2x} - v_{e1x}) = [586.6][18.41 - (-16.98)]$

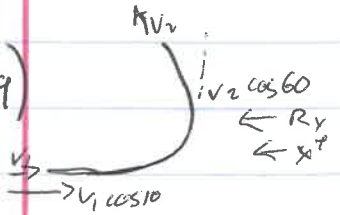
$R_x = 20.76 \text{ kN}$

force in y

$R_y = m_e(\Delta v_{ey}) = M_e(v_{e2y} - v_{e1y}) = (586.6)[0 - (+7.76)]$

$R_y = -4.55 \text{ kN}$

16.29)



$m = \rho A V$

$R_x = M(\Delta V_2) = M(V_{2x} - V_{1x})$

$A = \pi D^2/4 = \pi(0.00875)^2/4 = 4.418 \times 10^{-5}\ m^2$

$M = \rho A V = (1000)(4.418 \times 10^{-5})(25) = 1.105\ kg/s$

$V_{1x} = V_1 \cos(10) = (25)(0.985) = 24.62\ m/s$

$V_{1y} = V_1 \sin(10) = (25)(0.174) = 4.34\ m/s$

$V_2 = V = 25\ m/s$

$V_{2x} = V_2 \cos(60) = (25\ m/s)(0.5) = 12.5\ m/s$ $V_{2y} = V_2 \sin(60)$

$= (25)(0.0866) = 21.65\ m/s$

Force in x

$R_x = M(\Delta V_x) = M(V_{2x} - V_{1x}) = 1.105\ kg/s[12.5 - (-24.62]$

$R_x = 41.0\ N$

Force in y

$R_y = M(\Delta V_y) = M(V_{2y} - V_{1y}) = (1.105\ kg/s)[21.65 - 4.34])$

$R_y = 19.1\ N$