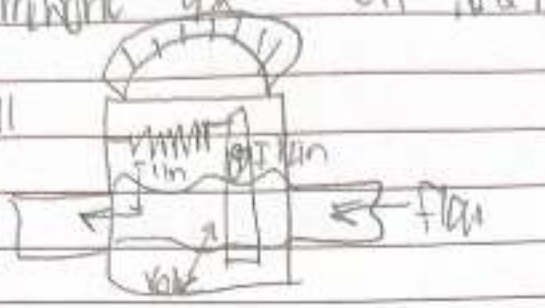
Homework 9.8 Ch 16 & 17

16.11



design

data

$Q = 110 \text{ gal/min} = .2228 \text{ ft}^3/\text{s}$

1in 40 steel pipe

$A = 0.006 \text{ ft}^2$

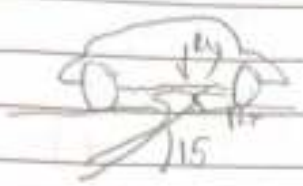
$\rho = 1.94 \text{ lb/ft}^3$

$F = \rho Q (V_2 - V_1)$

$V = \frac{Q}{A} = \frac{.2228}{.006} = 37.13 \text{ ft/s}$

$F = (1.94 \text{ lb/ft}^3)(.2228)(37.13 - (-37.13)) = 32.11 \text{ lb}$

16.20



data
V = 30 m/s
d = 20 cm = .2 m

$Q = \frac{\pi}{4} d^2 V = \frac{\pi}{4}(.20)^2(30) = 0.942 \text{ m}^3/\text{s}$

$R_x = \rho Q(V_{2x} - (-V_{1x}\cos\theta)) = \rho Q V(1+\cos\theta) = 1000(.942)(30+30\cos 15)$
$= 55618.1 \text{ N}$

$R_y = \rho Q(V_{2y} - (-V_{1y}\sin\theta)) = 1000(.942)(0+30\sin 15) = 7072.5 \text{ N}$

$V_x = V\cos\theta = 30\cos 15 = 28.98 \text{ m/s}$
$V_{1x} = V_x - V_{car} = 28.95 - 12 = 16.98 \text{ m/s}$
$V_y = V\sin\theta = 30\sin 15 = 7.76 \text{ m/s}$

$V_c = \sqrt{V_{1x}^2 + V_y^2} = \sqrt{16.98^2 + 7.76^2} = 18.67 \text{ m/s}$

$\dot{m} = \rho \frac{\pi}{4} d^2 V_c = 1000 \frac{\pi}{4}(.2)(18.67) = 586.6 \text{ kg/s}$

$\alpha = \tan^{-1}\left(\frac{V_y}{V_x}\right) = \tan^{-1}\left(\frac{7.76}{16.98}\right) = 24.56°$

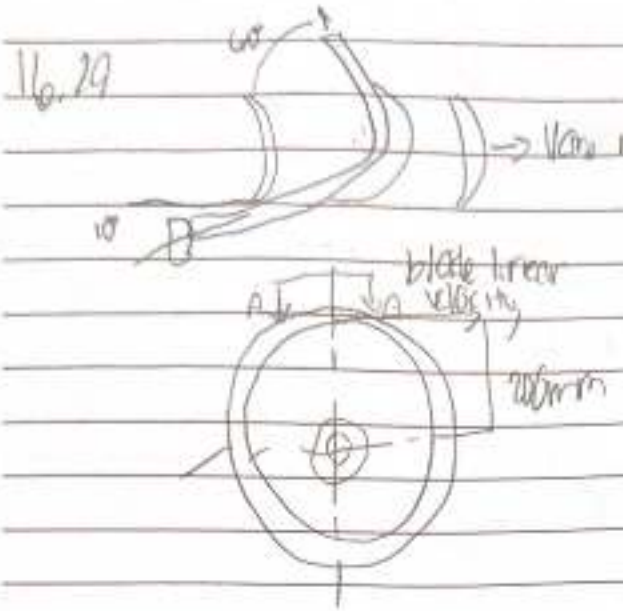
$\beta = \alpha - \theta = 7.56°$

$V_{cx} = V_c\cos\beta = 18.67\cos 4.56 = 18.4 \text{ m/s}$

$R_{xc} = \dot{m}(\Delta V_x) = 586.6(18.4 - 16.98) = \boxed{832.97 \text{ N}}$

$R_{yc} = \dot{m}(\Delta V_y) = 586.6(0 - (-7.76)) = \boxed{4552.02 \text{ N}}$

16.29



data
d = 7.5mm = .0075m
V = 25m/s
15°C water
ρ = 1000

$A = \frac{\pi}{4} d^2 = \frac{\pi}{4} (.0075)^2 = 4.42 \times 10^{-5}\ m^2$

$Q = AV = 4.42 \times 10^{-5}(25) = 1.105 \times 10^{-3}\ m^3/s$

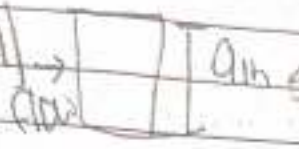
$R_x = \rho Q (V_2 \cos\theta + V_1 \cos\theta) = 1000(1.105 \times 10^{-3})(25\cos 60 + 25\cos 10)$
$= 41N$

$R_y = \rho Q (V_2 \sin\theta + V_1 \sin\theta) = 1000(1.105 \times 10^{-3})(25\sin 60 + 25\sin 10)$
$= 14.12N$

17.16)

Data
L = 60in = 5 ft
W = 9in = 0.75 ft
V = 100 mph = 146.7 ft/s
T = -20 F
ρ = 2.8x10^-3 slug/ft^3
ν = 1.17x10^-4 ft^2/s

a)



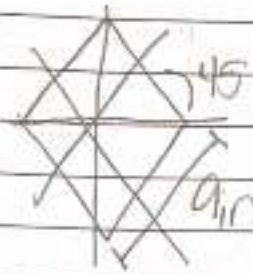
$N_R = \frac{VL}{\nu} = \frac{146.7(.75)}{1.17\times10^{-4}} = 9.4\times10^5$

$A = l_w = 5(.75) = 3.75 ft^2$

$C_D = 2.16$

$F_D = C_D\left(\frac{\rho V^2}{2}\right)A = 2.1\left(\frac{(2.8\times10^{-3})(146.7)^2}{2}\right)3.75 = 237.27 lb$

b)



$y = .75\sin 45 = .5303$

$A = l2_y = 5(2)(.5303) = 5.3 ft^2$

$C_D = 1.6$

$F_D = C_D\left(\frac{\rho V^2}{2}\right)A = 1.6\left(\frac{(2.8\times10^{-3})(146.7)^2}{2}\right)5.3$

$F_D = 255.6 lb$

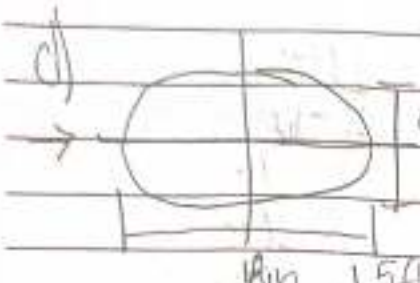
c)

$A = l_w = 5(.75) = 3.75 ft^2$

$N_R = 9.4\times10^5 \quad C_D = .3$

$F_D = C_D\left(\frac{\rho V^2}{2}\right)A = .3\left(\frac{(2.8\times10^{-3})(146.7)^2}{2}\right)3.75$

$F_D = 33.8 lb$



$A = \ell w = 3.75 ft^2$

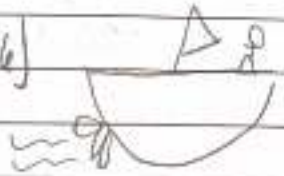
$N_R = \frac{VL}{\nu} = \frac{146.7(1.5)}{1.17 \times 10^{-4}} = 1.88 \times 10^6$

$C_D = .25$

$F = C_D \left(\frac{\rho V^2}{2}\right) A = .25 \left[\frac{(2.8 \times 10^{-3})(146.7^2)}{2}\right] 3.75$

$= 28.25 lb$

17.26)



Data

$V = 50$ ft/s

.004

$T = 77°F$

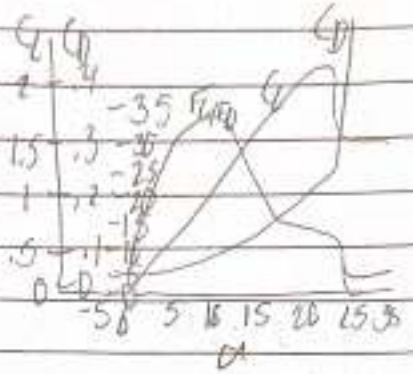
$\Delta = 125$ tons $= 2.8 \times 10^5$ lb

$P = R_{TS} V$

$R_{TS} = \text{ratio}(\Delta) = .004(2.8 \times 10^5) = 1680 lb$

$P = 1680(50) = 84601b\ ft/s = 152.73 hp$

7.30)



$\alpha = 10°$
$C_D = .05$
$C_L = 0.9$
$b = 6.8m$
$V = 200 km/hr = 55.5 m/s$
$C = 1.4m$

$A = c(b) = 1.4(6.8) = 9.52 m^2$

a)
$200m = 1.202 kg/m^3 = \rho$

$F_D = C_D\left(\frac{\rho V^2}{2}\right)A = .05\frac{(1.202)(55.55^2)}{2}(9.52) = 882.7N$

$F_L = C_L\frac{\rho V^2}{2}A = .9\frac{(1.202)(55.55^2)}{2}9.52 = 15.9N$

b) $10000m \quad \rho = .4135 kg/m^3$

$F_D = .05\frac{(.4135)(55.55^2)}{2}(9.52) = 363.6N$

$F_L = .9\frac{(.4135)(55.55^2)}{2}(9.52) = 5.47N$