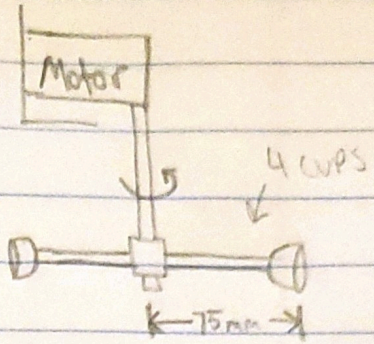
HW 2.2

17.11 $q_{air} = 30°C$

$q_{gas} = 20°C$

$N_R = {}^{vl}/_{v}$

$20\ r/min = 0.333\ r/sec$



a) $V = 2\pi r(0.075m)(0.333\ r/sec) = 0.157\ m/s$

From table E.1 → $30°C = 1.60 \times 10^{-5}\ m^2/s$

$N_R = (0.157\ m/s)(0.025m)/1.60 \times 10^{-5}\ m^2/s = 245.313$

From table 17.1 → $C_D = 1.35$

From table E.1 → $\rho = 1.164\ kN/m^3$

$F_D = C_D(\rho v^2/2)A = 1.35\left((1.164\ kN/m^3)(0.157\ m/s)^2/2\right)(0.000491\ m^2)$

$F_D = 9.51 \times 10^{-6}\ N$

$T = 4(9.51 \times 10^{-6}\ N \times 0.075m) = \boxed{2.853 \times 10^{-6}\ N.m}$

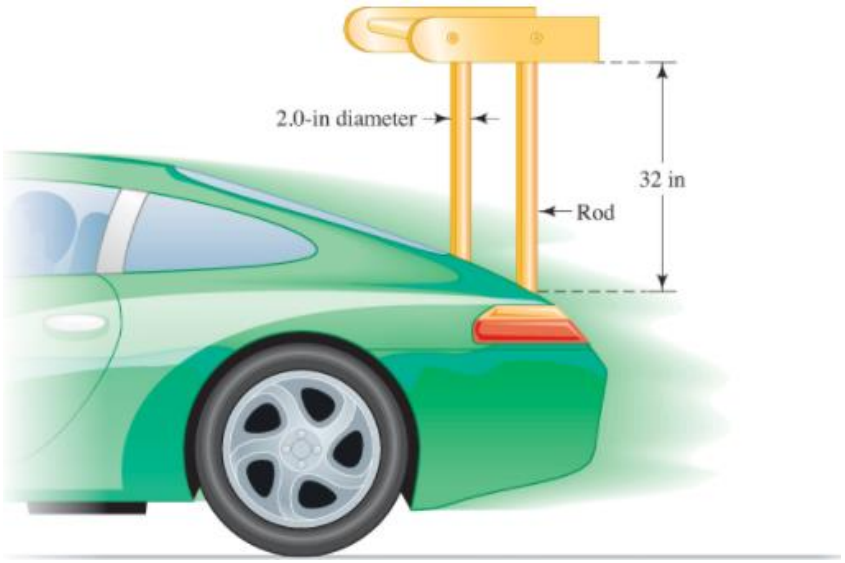
b) From table B.1 → Gasoline @ $20°C = 4.22 \times 10^{-7}\ m^2/s$

$N_R = (0.157\ m/s)(0.025m)/4.22 \times 10^{-7}\ m^2/s = 9300.948$

From table B.1 → $\rho = 680\ kN/m^3$

$F_D = 1.35\left((680\ kN/m^3)(0.157\ m/s)^2/2\right)(0.000491\ m^2) = 0.00556\ N$

$T = 4(0.00556\ N \times 0.075m) = \boxed{0.00167\ N.m}$


2.0-in diameter
32 in
Rod

19

$L = 2.67\,ft \quad D = 0.167\,ft \quad T = -20°f \quad V = 220\,ft/s$

Viscosity of Air at $-20°f$

$\nu = 1.17 \times 10^{-4}\,ft^2/s$

Reynolds number

$$N_R = \frac{VD}{\nu}$$

$$N_R = \frac{220 \times 0.167}{1.17 \times 10^{-4}}$$

$$N_R = 3.14 \times 10^5$$

Density of air at $-20°f$

$\rho = 2.8 \times 10^{-3}\,slugs/ft^3$

Area of rod

$$A = D \cdot 2L$$

$$0.167 \cdot 5.34$$

$$A = 0.891\,ft^2$$

Drag force

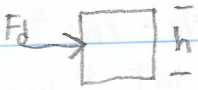
$$F_D = \frac{0.8 \cdot 2.8 \times 10^{-3} \cdot 0.891 \cdot 220^2}{2}$$

$$F_D = 48.29\,lb$$

16. $L = 60\ in \quad h = 9\ in \quad V = 100\ mph = 146.67\ \frac{ft}{s} \quad \nu = 1.17 \cdot 10^{-4}\ \frac{ft^2}{s} \quad \rho = 0.0028\ \frac{Slug}{ft^3}$

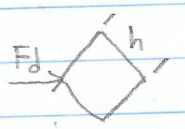
a) $Re = \frac{V \cdot h}{\nu} = 9.4 \cdot 10^5 \quad Cd = 2 \quad A = L \cdot h = 3.75\ ft^2$

$Fd = \frac{Cd \cdot A \cdot \rho \cdot V^2}{2} = 225.88\ lb$



b) $d = 2 \cdot 9 \cdot \sin 45 = 1.06\ ft \quad Cd = 1.6 \quad A = d \cdot L = 5.3\ ft^2$

$Fd = \frac{Cd \cdot A \cdot \rho \cdot V^2}{2} = 255.55\ lb$

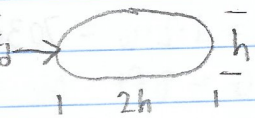


c) $Re = \frac{V \cdot h}{\nu} = 9.4 \cdot 10^5 \quad Cd = 0.3 \quad A = L \cdot h = 3.75\ ft^2$

$Fd = \frac{Cd \cdot A \cdot \rho \cdot V^2}{2} = 33.88\ lb$

d) $Re = \frac{V \cdot 2 \cdot h}{\nu} = 1.88 \cdot 10^6 \quad Cd = 0.2 \quad A = L \cdot h = 3.75\ ft^2$

$Fd = \frac{Cd \cdot A \cdot \rho \cdot V^2}{2} = 22.59\ lb$

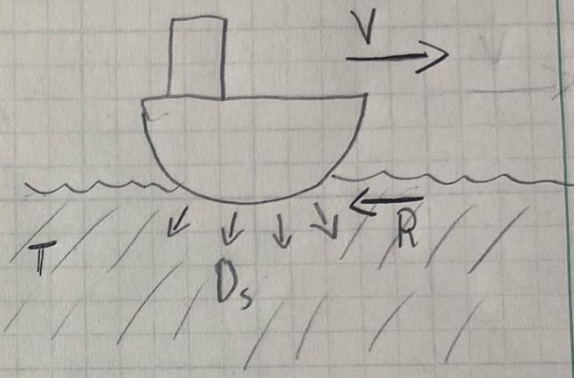


Design d has lowest drag, design b has highest drag.

17.26

$V = 50$ ft/s
$T = 77°F$
$SRR = 0.06$
$D_s = 125$ Long tons
1 long ton $= 2240$ lbs

$R = SRR(D_s)$
$P = RV$



$D_s = 2240(125)$
$D_s = 280000$ lbs

$R = 0.06(280000)$
$R = 16800$ lbs

$P = 16800(50)$
$P = 840000 \frac{lb\text{-}ft}{s}$

$550 \frac{ft\text{-}lb}{s} = 1$ hp

$P = \frac{840000}{550}$

$P = 1527.27$ hp

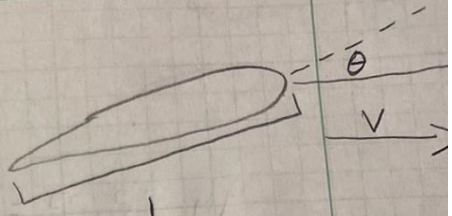
17.30

$L = 1.4\ m$

$s = 6.8\ m$

$\theta = 10°$

$V = 200\ km/h = 55.55\ m/s$

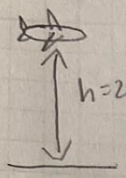


$Area = LS = (1.4)(6.8)$

$A = 9.52\ m^2$

$C_L = 0.9$ > From Diagram

$C_D = 0.05$ > From Diagram



a) $h = 200\ m$

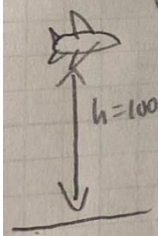
$D_{air} = 1.202\ kg/m^3$ @ 200 m – From table

$$F_D = \frac{(1.202)(55.55)^2(9.52)(0.05)}{2}$$

$$\boxed{F_D = 882.77\ N}$$

$$F_L = \frac{(1.202)(55.55)^2(9.52)(0.9)}{2}$$

$$\boxed{F_L = 15889.93\ N}$$



b) $h = 10000\ m$

$D_{air} = 0.4135\ kg/m^3$ @ 10000 m – From table

$$F_L = \frac{(0.4135)(55.55)^2(9.52)(0.9)}{2}$$

$$\boxed{F_L = 5466.3\ N}$$

$$F_D = \frac{(0.4135)(55.55)^2(9.52)(0.05)}{2}$$

$$\boxed{F_D = 303.7\ N}$$