17.11, 14, 16, 26, 30

17.14 A wing on a race car is supported by two cylindrical rods, as shown in the figure. Compute the drag force exerted on the car due to these rods when the car is traveling through still air at −20°F at a speed of 150mph

$F_D = C_D \frac{1}{2} \rho V^2 A$

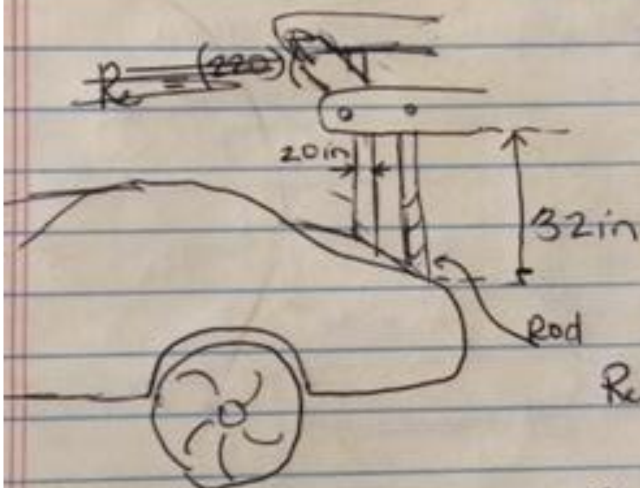
ρ_{air} @ −20°F = 2.80×10^{-3}

η_{air} @ −20°F = 3.27×10^{-7}

ν_{air} @ −20°F = 1.17×10^{-4}

$R_e = \frac{vD}{\nu} = \frac{\rho v D}{\eta}$

v = 150 mph = 220 ft/s



$\frac{150\,\cancel{mi}}{\cancel{hr}} \cdot \frac{1\,hr}{3600\,s} \cdot \frac{5280\,ft}{1\,\cancel{mi}} = 220$

$D = 2in = 0.1667ft$

$R_e = \frac{(220ft/s)(0.1667ft)}{1.17 \times 10^{-4}\,ft^2/s} = 215729.4$

(0.00017)

$C_D = 1.5$ based on chart

$F_D = 1.5(\tfrac{1}{2})(0.00280)(220ft/s)^2(0.8891) = \boxed{90.37\ lb}$

$A = (0.1667)(2.6667) = 0.4445 \times 2$ (2 rods) $= 0.8891$

17.16 The four designs shown in the figure for the cross section of an emergency flasher lighting system for police vehicles are being evaluated. Each has a length of 60 in (5 ft) & a width of 9.00 in (0.75 ft). Compare the drag force exerted on each proposed design when the vehicle moves @ 100 mph through still air @ −20°F

$F_D = C_D \frac{1}{2} \rho v^2 A$

circular $R_e = \frac{vD}{\nu} = \frac{\rho v D}{\eta}$

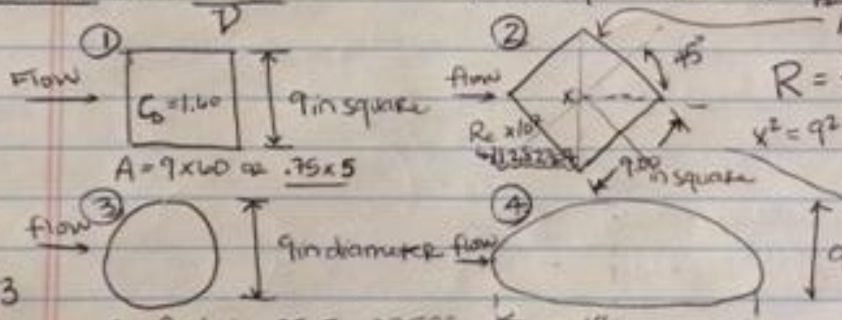
noncircular $R_e = \frac{v(4R)}{\nu}$

ρ_{air} @ −20°F = 2.80×10^{-3} slugs/ft³

η_{air} @ −20°F = 3.27×10^{-7} lb-s/ft²

ν_{air} @ −20°F = 1.17×10^{-4} ft²/s

v = 100mph = 146.67ft/s



A = 5 x 1.06

$R = \frac{9 \times 9}{9 \times 4} = \frac{81}{36} = 2.25$

$x^2 = 9^2 + 9^2 = 162$

x = 12.728 in = 1.06ft

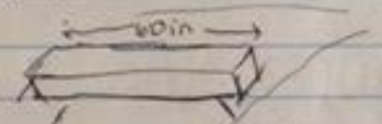
$C_D \approx 2$

A = 9x60 or .75x5

$C_D \sim 0.3$

A = 9x60 .75x5 = 3.75ft²

A=9x60 .75x5 = 3.75ft²



① $F_D = (1.60)\frac{1}{2}(0.00280 \text{ slugs/ft}^3)(146.67 \text{ ft/s})^2(3.75 ft^2)$

$\boxed{F_D = 1.232 \text{ lb}}$

I assumed C_D = ~2.0 my Reynolds # wasn't on chart

② $F_D = (2)(\frac{1}{2})(0.0028 \text{ slugs/ft}^3)(146.67 \text{ ft/s})^2(5.3 ft^2)$

$\boxed{F_D = 319.24 \text{ lb}}$

③ $F_D = (0.3)(\frac{1}{2})(0.0028 \text{ slugs/ft}^3)(146.67 \text{ ft/s})^2(3.75 ft^2)$

$\boxed{F_3 = 33.88 \text{ lb}}$

④ If I assume 9in diameter to find Reynold's number, I am left with all the same numbers as design 3. That gives me

$\boxed{F_D = 33.88 \text{ lb}}$