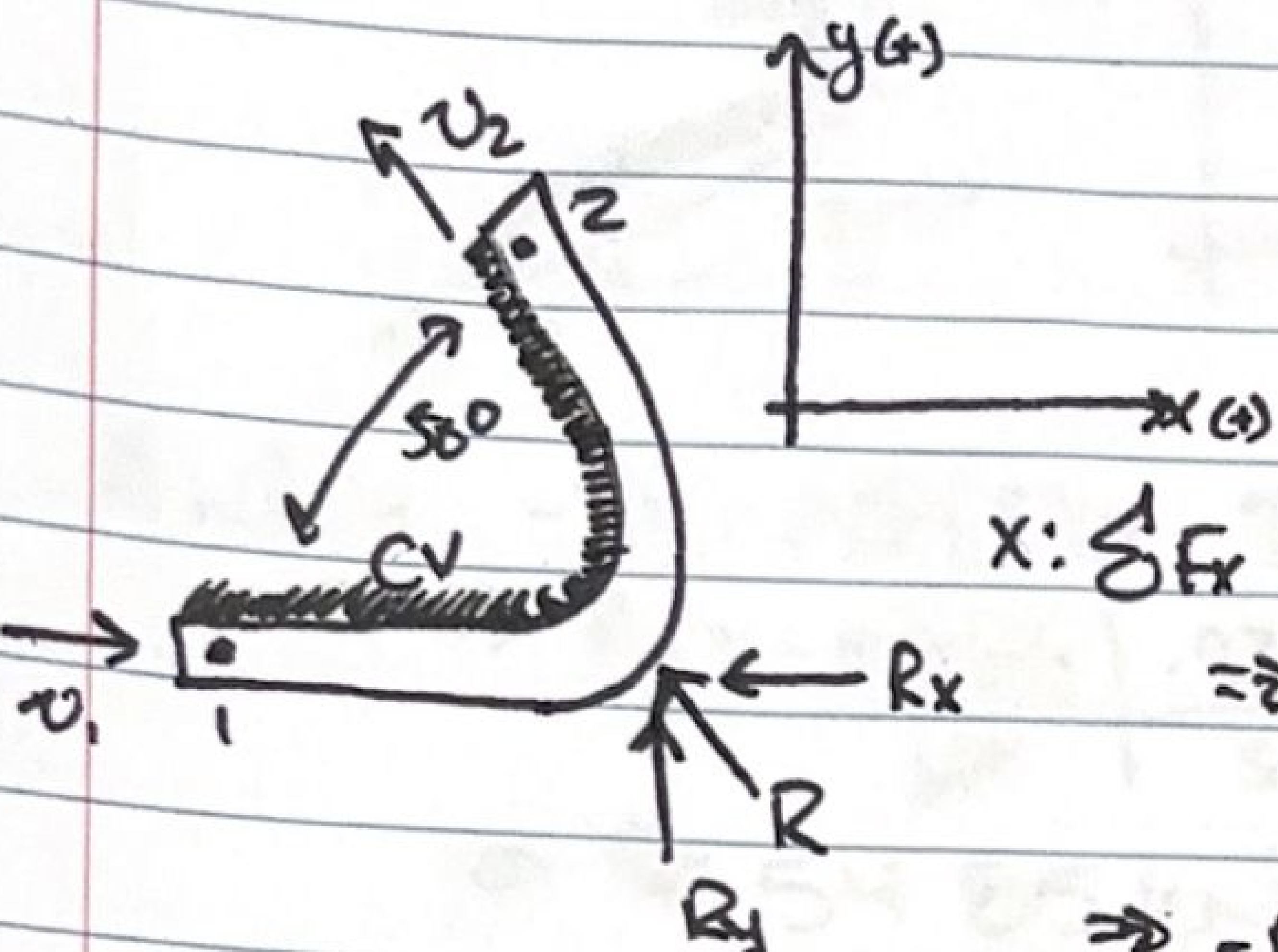
CH. 16 6, 11, 20, 29 ✓✓✓

JORDAN DAVIS

6) FIND R_x, R_y?

GIVEN: WATER @ 180°F → $\rho = 1.88\, slugs/ft^3 = 1.88\, lb \cdot s^2/ft^4$

$A = .0205\, ft^2$ $\quad v = 22\, ft/s \quad \phi = 50°$



$Q = Av_1 = .0205\, ft^2 (22\, ft/s)$

$= \underline{.451\, ft^3/s}$

X: $\sum F_x = -R_x = \rho Q (v_{2x} - v_{1x})$

$\Rightarrow -R_x = \dfrac{1.88\, lb \cdot s^2}{ft^4} \cdot \dfrac{.451\, ft^3}{s} \cdot \dfrac{(-22\cos 50 - 22)\, ft}{s}$

$\Rightarrow -R_x = -30.64 \Rightarrow \boxed{R_x = 30.64\, lbf}$

y: ~~R_y~~ $\sum F_y = R_y = \rho Q (v_{2x} - \cancel{v_{1x}}^{\,0})$

$\Rightarrow R_y = \dfrac{1.88\, lb \cdot s^2}{ft^4} \cdot \dfrac{.451\, ft^3}{s} \cdot \dfrac{22\sin 50\, ft}{s}$

$\Rightarrow \boxed{R_y = 14.29\, lbf}$

11) FIND F_s?

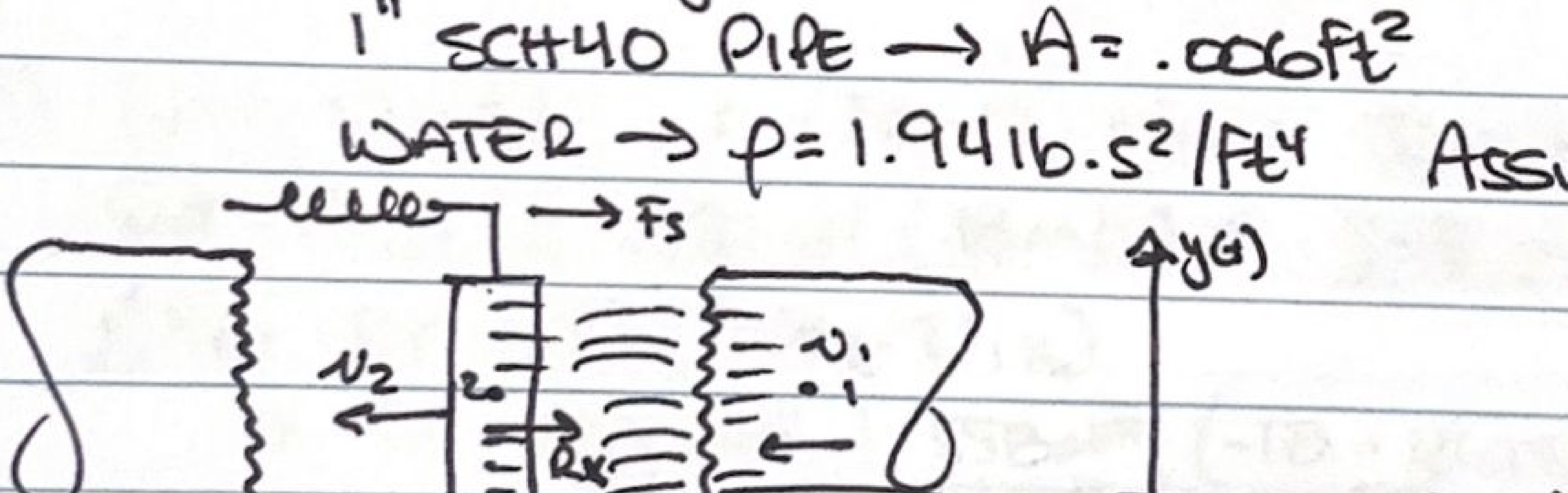
GIVEN: $Q = 100\, gal/min = .223\, ft^3/s$

1" SCH40 PIPE → $A = .006\, ft^2$

WATER → $\rho = 1.94\, lb \cdot s^2/ft^4$ ASSUMING 60°F

$v = Q/A$

$= \underline{37.17\, ft/s}$



~~[illegible]~~ $\sum F_x = F_s = \rho Q (v_{2x} - v_{1x})$

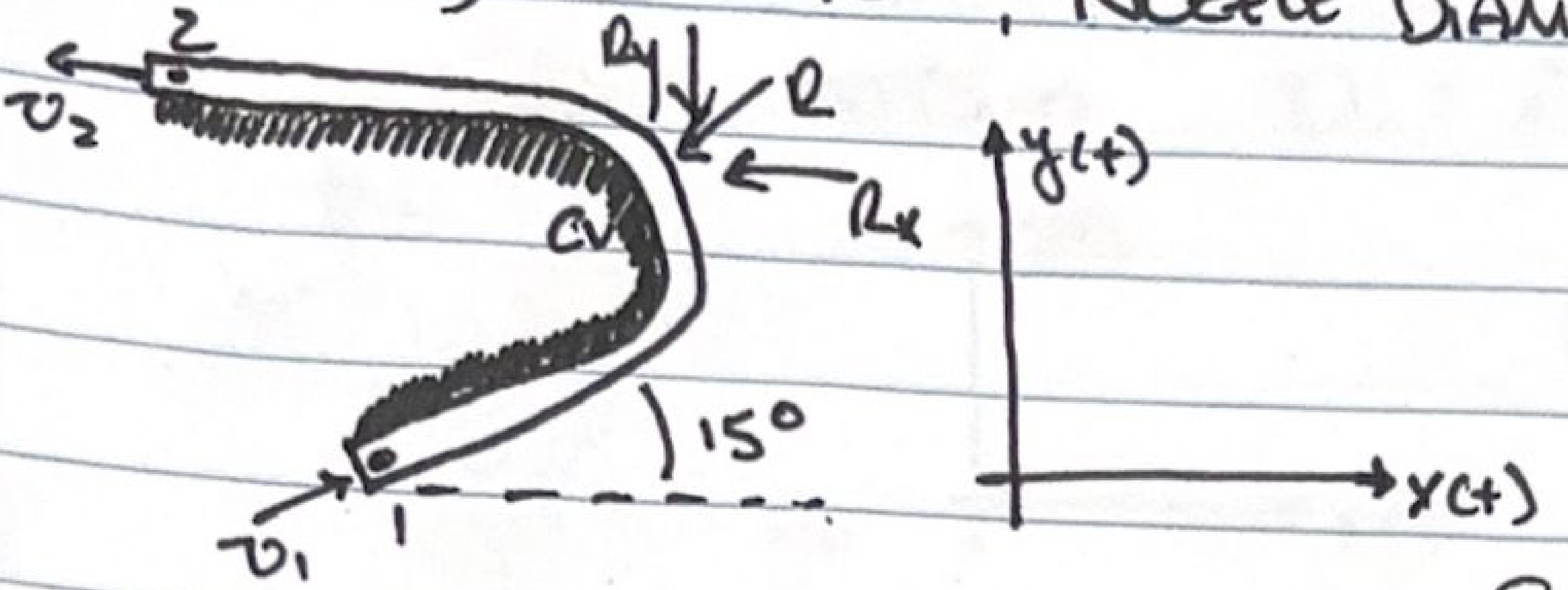
$\Rightarrow F_s = \dfrac{1.94\, lb \cdot s^2}{ft^4} \cdot \dfrac{.223\, ft^3}{s} \cdot \dfrac{(-37.17 - 37.17)\, ft}{s}$

$\Rightarrow F_s = -32.16\, lbf$ $\quad \Rightarrow$ $\boxed{F_s = 32.16\, lbf \leftarrow}$

PULLING METER BACK TO MIDDLE

20) FIND FORCE ON VEHICLE? A) STATIONARY B) MOVING @ 12 m/s

GIVEN: $v_j = 30$ m/s , NOZZLE DIAMETER = .2 m



$A = \frac{\pi D^2}{4} = .031 m^2$

$Q = vA = .93\ m^3/s$

$\rho = 1000\ kg/m^3$

A) $\sum F_x = -R_x = \rho Q (v_{2x} - v_{1x})$

$\Rightarrow R_x = -\frac{1000 kg}{m^3} \Big| \frac{.93 m^3}{s} \Big| \frac{(-30 - 30\cos 15) m}{s}$

$\Rightarrow R_x = 54.85$ kN

$\sum F_y = -R_y = \rho Q (v_{2x} - v_{1x})$

$\Rightarrow R_y = -\frac{1000 kg}{m^3} \Big| \frac{.93 m^3}{s} \Big| \frac{-30 \sin 15\ m}{s}$

$\Rightarrow R_y = 7.22$ kN

$\Rightarrow R = \sqrt{R_x^2 + R_y^2} = \sqrt{54.85^2 + 7.22^2} = 55.32$ kN

$\phi = \tan^{-1}(7.22/54.85) = 7.5$ DEG

$\boxed{\Rightarrow 55.32 \text{ kN } \angle 7.5° \text{ ON VEHICLE}}$

B) $v_e = v_1 - v_0 = (30 - 12)$ m/s $= \underline{18 m/s}$

$Q_e = A v_e = .031 m^2 (18 m/s) = \underline{.558 m^3/s}$

$\sum F_x = -R_x = \rho Q (v_{2x_e} - v_{1x_e})$

$\Rightarrow R_x = -\frac{1000 kg}{m^3} \Big| \frac{.558 m^3}{s} \Big| \frac{(-18 - 18\cos 15) m}{s}$

$\Rightarrow R_x = 19.75$ kN

$\sum F_y = -R_y = \rho Q (v_{2x_e} - v_{1x_e})$

$\Rightarrow R_y = -\frac{1000 kg}{m^3} \Big| \frac{.558 m^3}{s} \Big| \frac{(-18 \sin 15) m}{s}$

$\Rightarrow R_y = 2.6$ kN

$\Rightarrow R = \sqrt{R_x^2 + R_y^2} = \sqrt{19.75^2 + 2.6^2} = 19.92$ kN

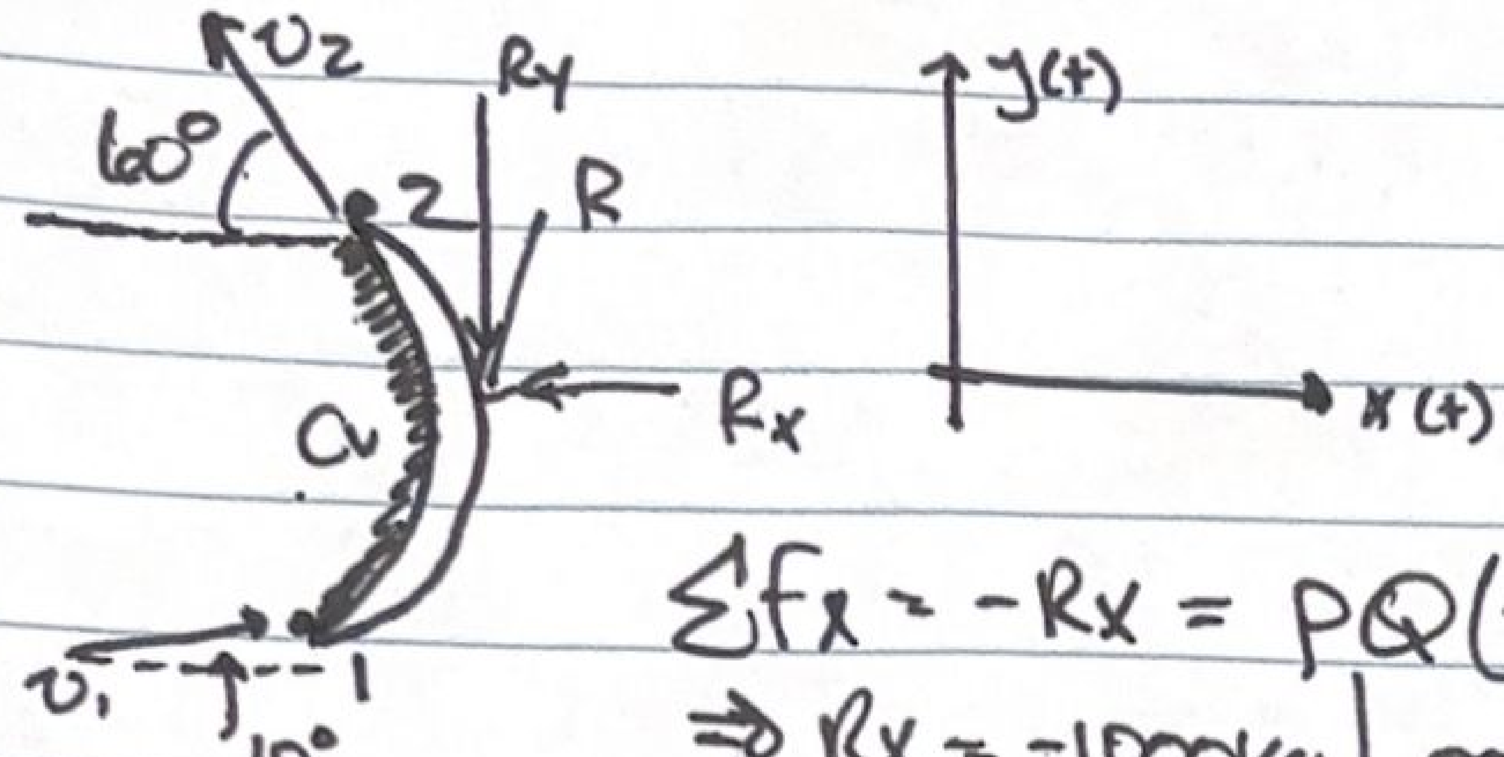
$\phi = \tan^{-1}(2.6/19.75) = 7.5$

$\Rightarrow$ $\boxed{\text{19.92 kN } \angle 7.5° \text{ ON MOVING VEHICLE}}$

29) FIND FORCE ON ONE BLADE?

GIVEN: WATER @ 15°C → $\rho = 1000\,kg/m^3$

$D_w = .0075\,m$ $\quad V_1 = 25\,m/s$



$$Q = VA = \frac{25\,m}{s} \cdot \frac{\pi(.0075)^2\,m^2}{4}$$

$$Q = .0011\,m^3/s$$

$$\Sigma F_x = -R_x = \rho Q(V_{2x} - V_{1x})$$

$$\Rightarrow R_x = -\frac{1000\,kg}{m^3} \cdot \frac{.0011\,m^3}{s} \cdot \frac{(-25\cos 60 - 25\cos 10)\,m}{s}$$

$\Rightarrow$ $\boxed{R_x = 40.8\,N}$ FORCE ON BLADE IN X DIRECTION →

$$\Sigma F_y = -R_y = \rho Q(V_{2x} - V_{1x})$$

$$\Rightarrow R_y = -\frac{1000\,kg}{m^3} \cdot \frac{.0011\,m^3}{s} \cdot \frac{(25\sin 60 - 25\sin 10)\,m}{s}$$

$\Rightarrow R_y = -19.04\,N \Rightarrow$ $\boxed{R_y = 19.04\,N \uparrow}$