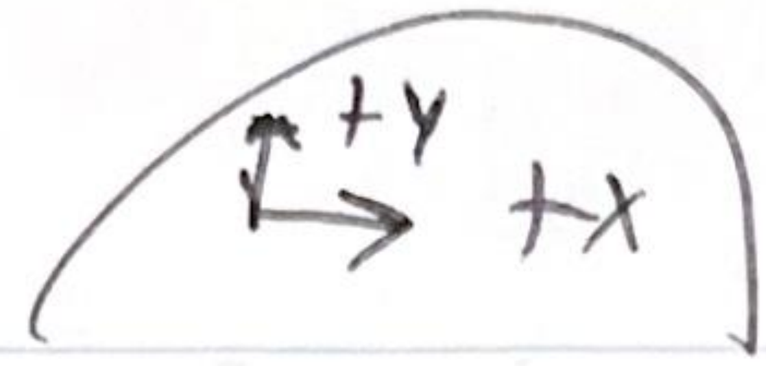
H/w 3.3 Callum [illegible]

November 20th 2024

MET 330



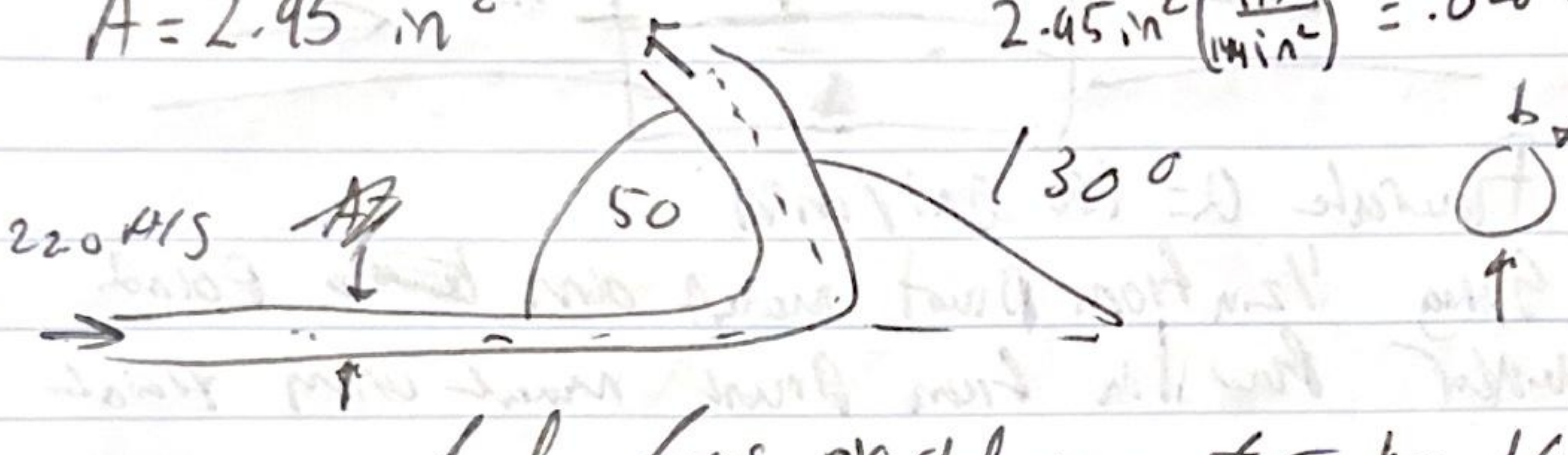
16.6 Given:

180 °F

130° angle through stationary vane $Q=VA$

enter velocity = 22.0 ft/s

$A = 2.95\ in^2$ $2.95\ in^2 \left(\frac{1 ft^2}{144 in^2}\right) = .02049\ ft^2$



find forces exerted on water by vane in vertical & horizontal position

So V_1 is a vector that looks like this

→ 22.0 ft/s and ends like ↖ 130°

$F = \rho Q \Delta V$

(table A-2)

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

$F_y = \rho Q(V_{2y} - V_{1y})$

$Q = VA$

$Q = (22\ ft/s)(.02049\ ft^2)$

$Q = .4507\ ft^3/s$

and $\rho =$ @ 180°F (A-2)

1.88 slugs/ft³

$\cos 50° = X / 22.0\ ft/s$

$X = 14.14\ ft/s$

$R_x = (1.88\ slugs/ft^3)(.4507\ ft^3/s)(-14.14\ ft/s - 22.0\ ft/s)$

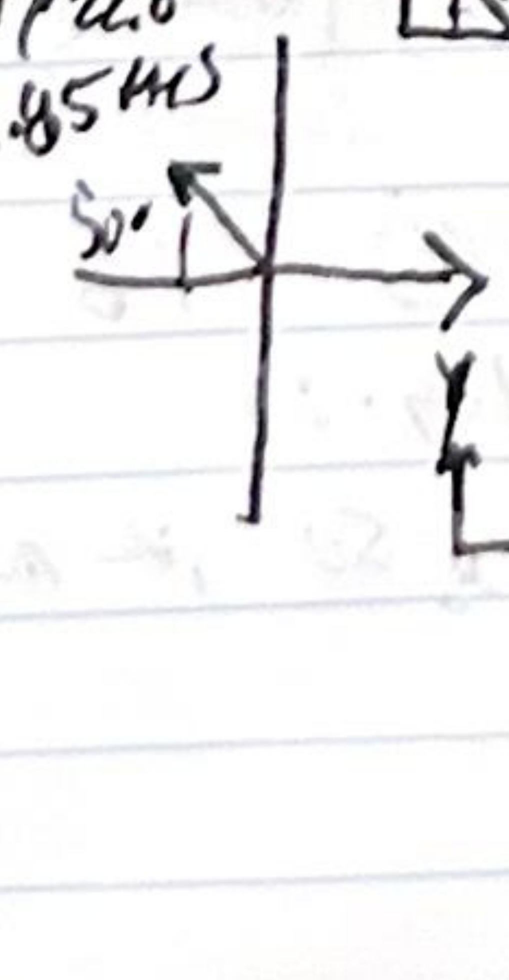
$F_x = -30.6$ slugs (30.6 slugs to the left)

$\sin 50° = Y / 22.0$

$Y = 16.85\ ft/s$

and $F_y = (1.88\ slugs/ft^3)(.4507\ ft^3/s)(16.85\ ft/s - 0)$

$= 14.27$ slugs up

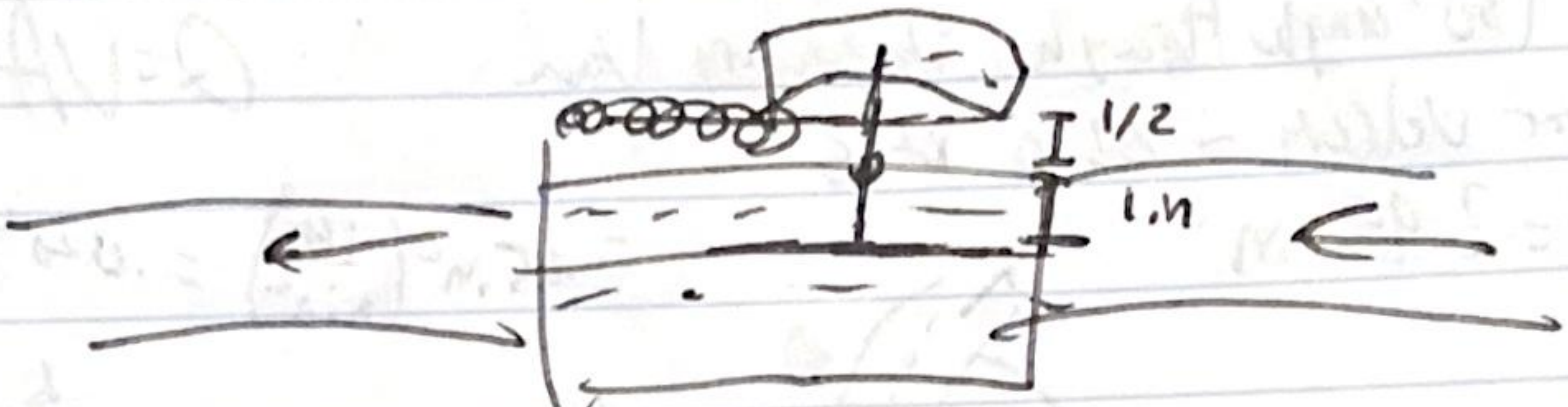


F_x the horizontal force is 30.6 slugs "left"

F_y The vertical force is 14.3 slugs "up"

16-11 the water flows through and pushes the meter, held back by spring for calibration.

Assuming 80 °F?



given: Flowrate Q = 100 gal/min
Spring 1/2 in from pivot moment arm point
water flow 1 in from pivot moment arm point

The needle only moves if the resultant force is not equal to zero, find spring force to keep it still from a 1 in sch 40 pipe

1 in Schedule 40 pipe area from (F-1)

$A = .00600 \text{ ft}^2$

Also app k convert $100 \text{ gal/min} \left(\frac{1 \text{ ft}^3/\text{s}}{449 \text{ gal/min}} \right)$

$Q = .223 \text{ ft}^3/\text{s}$

$Q = VA \quad \frac{0.223 \text{ ft}^3/\text{s}}{.00600 \text{ ft}^2} = ~~37 ft/s~~ \; 37.2 \text{ ft/s}$

So $F = \rho Q \Delta V$ and $\rho = 1.93 \text{ slugs/ft}^3$ @ 80 °F assumed

~~[illegible]~~ ~~F = (1.93 slugs/ft³)(37.2 ft/s)(~~

32 slugs

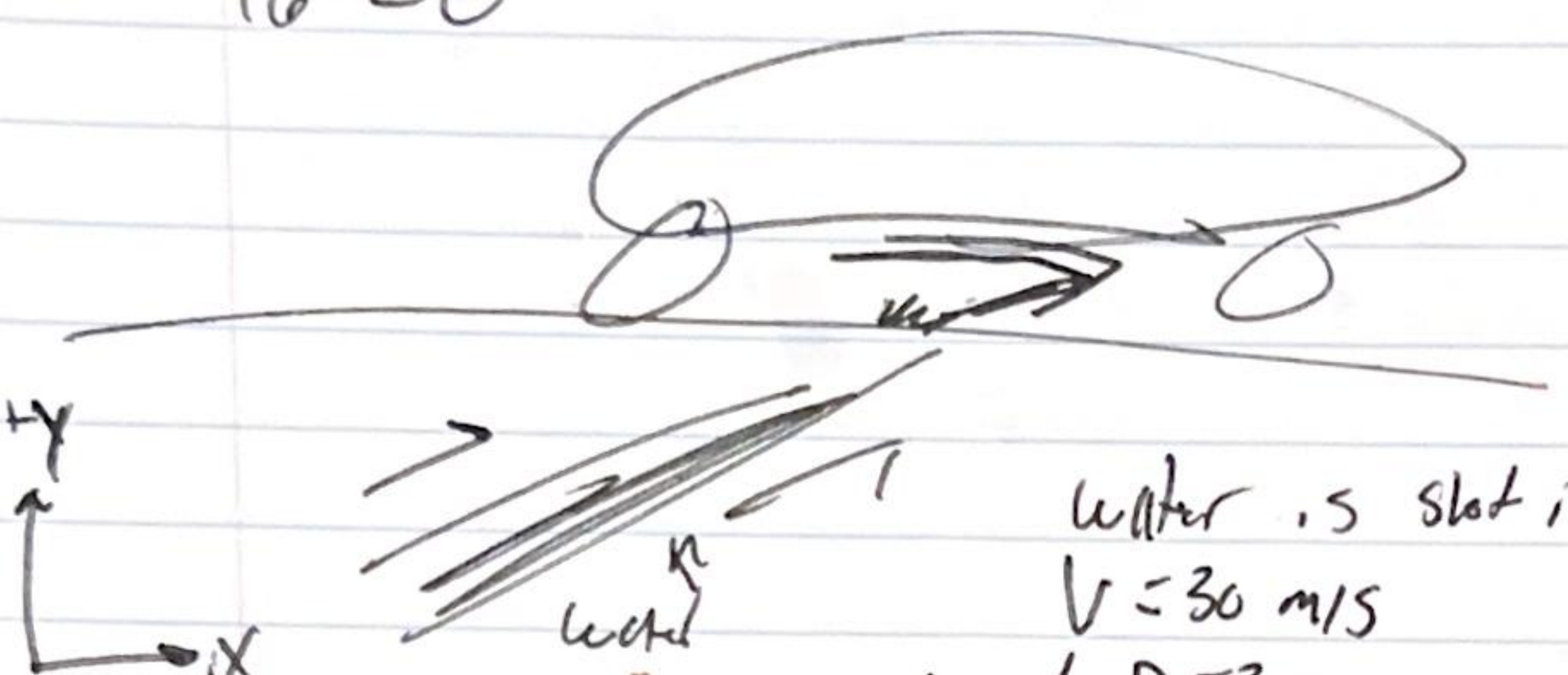
$F = (1.93 \text{ slugs/ft}^3)(.223 \text{ ft}^3/\text{s})(37.2 \text{ ft/s}) = 16 \text{ slugs}$

or @ a 1 in moment arm that's 16 ~~slugs~~ slug·in

the spring is half the moment arm length, so it must be doubly force 32 slugs!

$(32 \text{ slugs})(1/2 \text{ in}) = 16 \text{ slug·in}$

16.20



given ~~Assume 80 F~~ Assume 20 °C

previous day out

water is shot in a 15° vane @20°C; ρ = 998 kg/m³

V = 30 m/s

Nozzel D = 200 mm = .2 m

$A = \pi(.1\,m)^2 = (\pi/100)\,m^2$

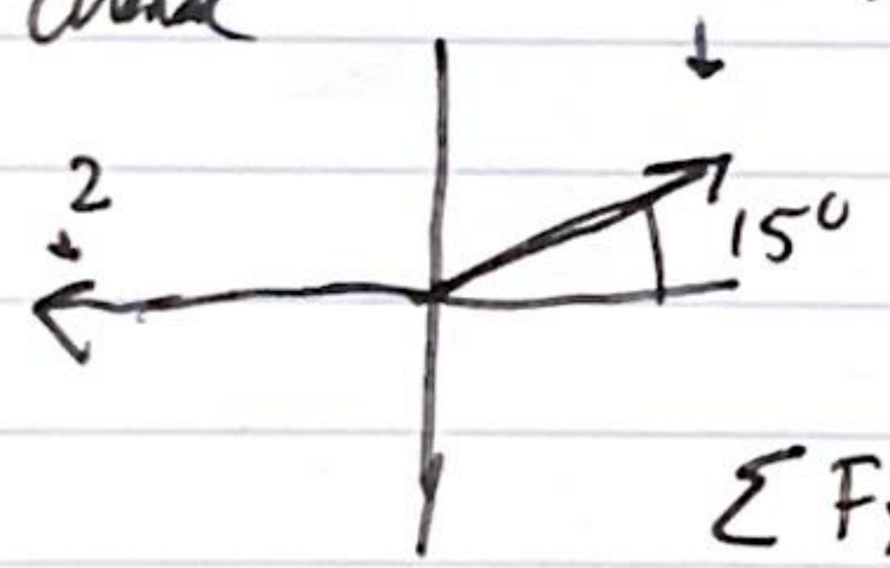
a.) force on stationary?

$F = \rho Q \Delta V$ → $Q = VA$

$Q = (30\,m/s)(\pi/100)\,m^2$

$= .94\,m^3/s$

heres the water change



$30\,m/s\,(\sin 15) = F_{y_1}$

$30\,m/s\,(\cos 15) = F_{x_1}$

$\Sigma F_x = (998\,kg/m^3)(.94\,m^3/s)(0 - (30\,m/s)(\cos 15))$

27184

$\Sigma F_x = 27184\ kg \cdot m/s^2$ or N

and $\Sigma F_y = (998\,kg/m^3)(.94\,m^3/s)(0 - (30\,m/s)(\sin 15))$

$\Sigma F_y = 2284\ kg \cdot m/s^2$ or N

total force is $F = \sqrt{27184^2 + 7284^2} = 28143\ N$

$= 28.1\ kN$

or around (or 55.8 kN)

b. 12 m/s is the same with a lesser X component

$\Sigma F_x = (998\,kg/m^3)(.94\,m^3/s)($