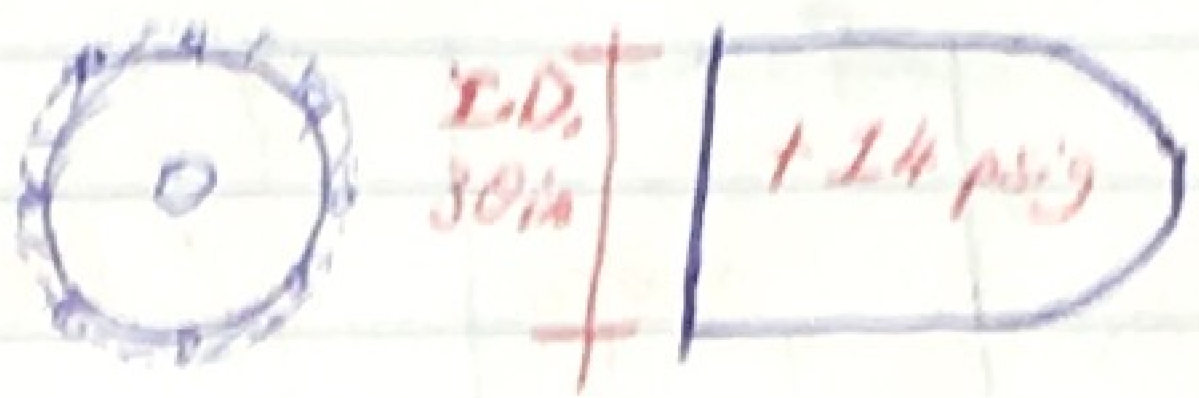
MET330 Team 5 HW2.1

Question 4.2



Given:

I.D. = 30"

Internal pressure = +14.4 psig

Required:

Total force that must be resisted by the bolts

$F = pA$

$A = \pi \cdot D^2 / 4$

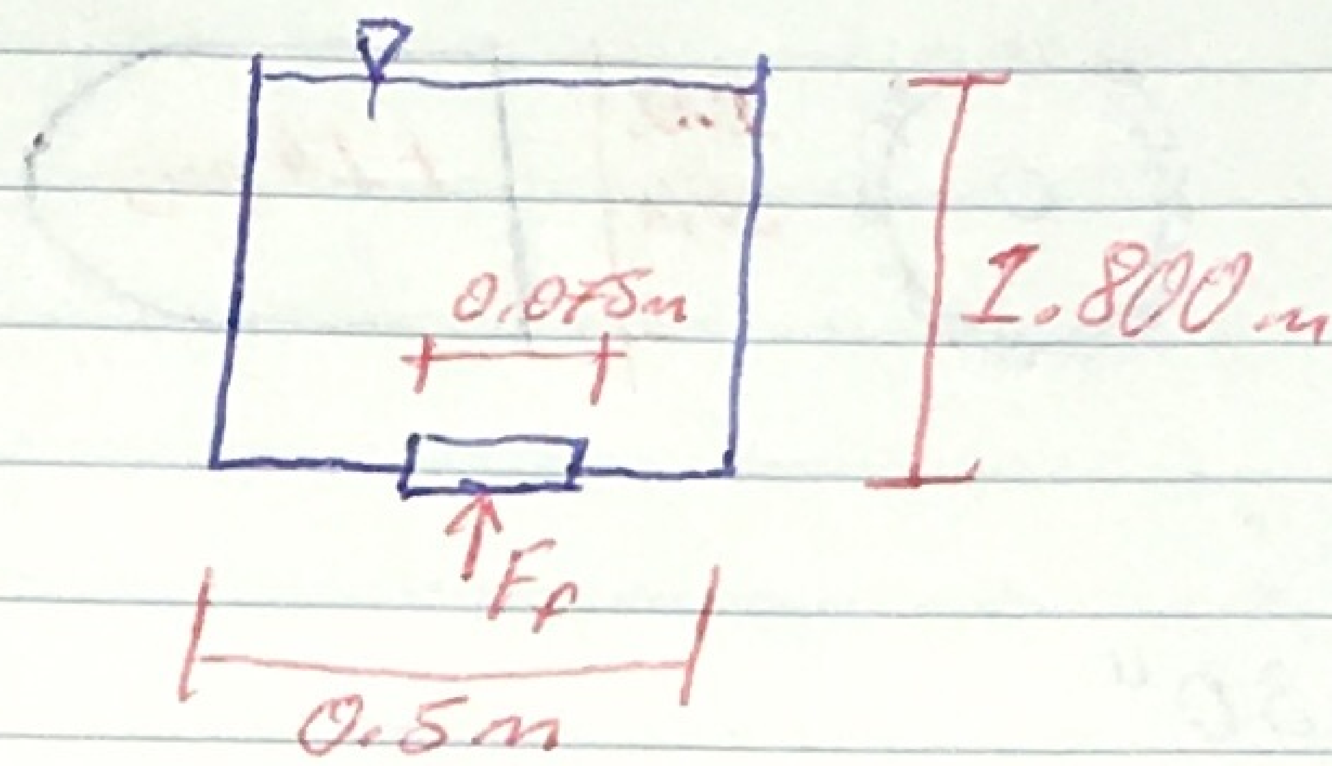
$\therefore F = \pi \times 30in^2 / 4 \times 14\ lb/in^2$

$= \boxed{9896.017\ lb}$

There are 8 bolts, each bold would resist 1237.002 lb.

MET330 Team 5 HW 2.1

Question 4.10



Given:

Water Tank ∴ $\gamma_w = 9.81\ KN/m^3$

Required:

Force needed to open the valve

$F = pA$

$A_R = \pi \times 0.075m^2 / 4$

$p = \gamma_w h = 9.81\ KN/m^3 \times 1.800m$

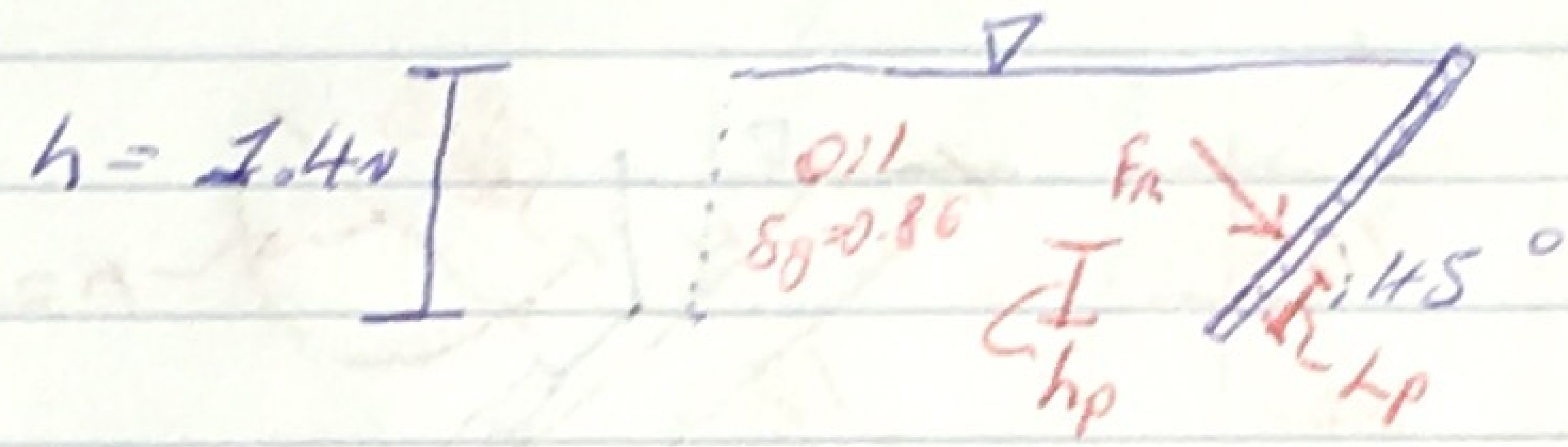
$\therefore F = \pi \times 0.075m^2 / 4 \times 9.81\ KN/m^3 \times 1.800m$

$= \sout{78.011\ N}$

$= \boxed{78.011\ N}$

MET330 Team 5 HW2.1

Question 4.17



Given:

Sg oil = 0.86

$\gamma_o = 0.86 \times 9.81\ KN/m^3 = 8436.6\ N/m^3$

Wall horizontal length = 4 m

Required:

The total force on the wall due to oil ~~pr~~ pressure.

The center of pressure h_p

$F_R = \gamma (h/2) A$

Area of wall face = $1.4m / \sin 45° \times 4m$

$= 7.92\ m^2$

$F_R = 8436.6\ N/m^3 \times (1.4m/2) \times 7.92\ m^2$

$= 46770.124\ N$

$= \boxed{46.770\ KN}$

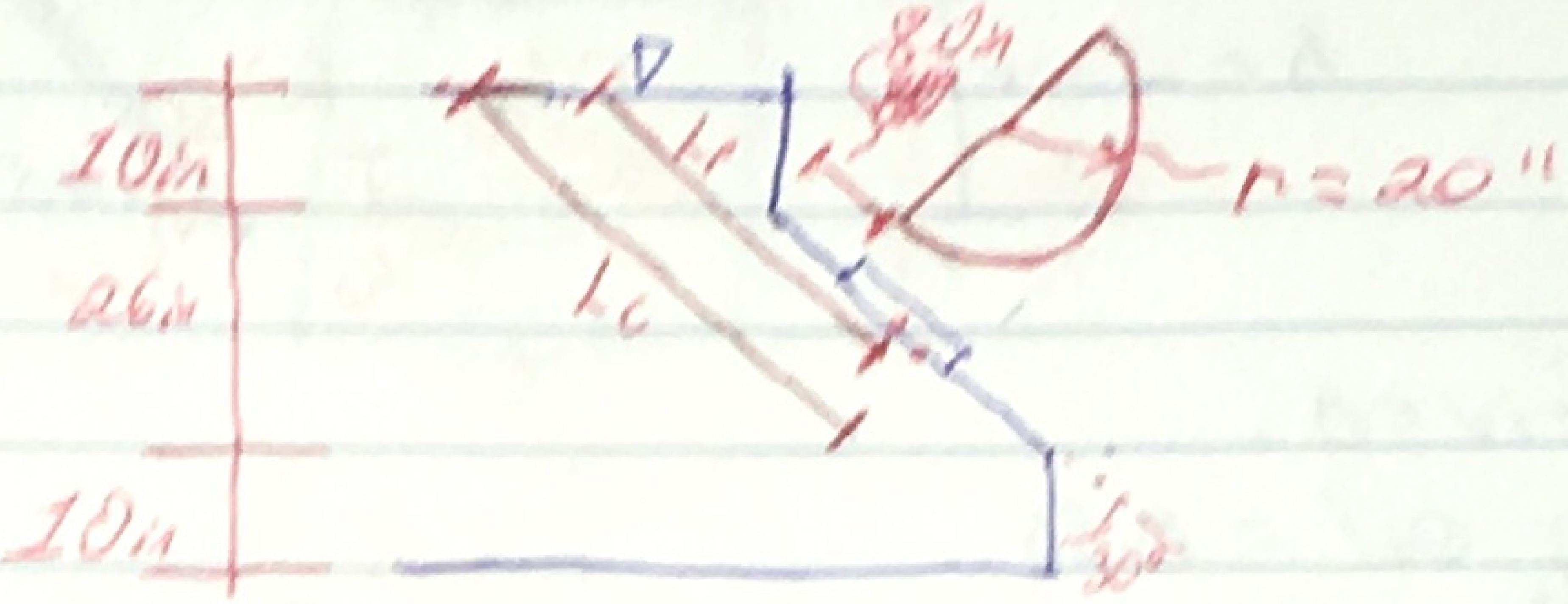
Calculating center of pressure

$h_p = h/3 = 1.4m/3 = \boxed{0.467\ m}$

$L_p = 1.4m / \sin 45° / 3 = \boxed{0.66\ m}$

MET330 Team 5 HW2.1

Question 4.28



Given:

Tank contains Ethylene Glycol – $S_g = 1.10$

$\gamma_g = 1.10 \times 62.4\, lb/ft^3 = 68.64\, lb/ft^3$

Required:

The magnitude of the resultant force – F_R

The center of pressure – L_p

Calculating the centroid of the hatch

$\Rightarrow 0.212\,D = 0.212 \times 40\,in = 8.48\,in$

$\therefore L_c = 8.48 + 8.0 + 10/\sin 30°$
$= 36.48"$

Calculating the moment of inertia – I_c

$I_c = (6.86 \times 10^{-3})\, 40^4\, in$

$L_p = \frac{I_c}{L_c A} + L_c = \frac{(6.86 \times 10^{-3})\, 40^4\, in}{36.48\,in \times \pi (20\,in)^2/2} + 36.48\,in = \boxed{37.25\,in}$

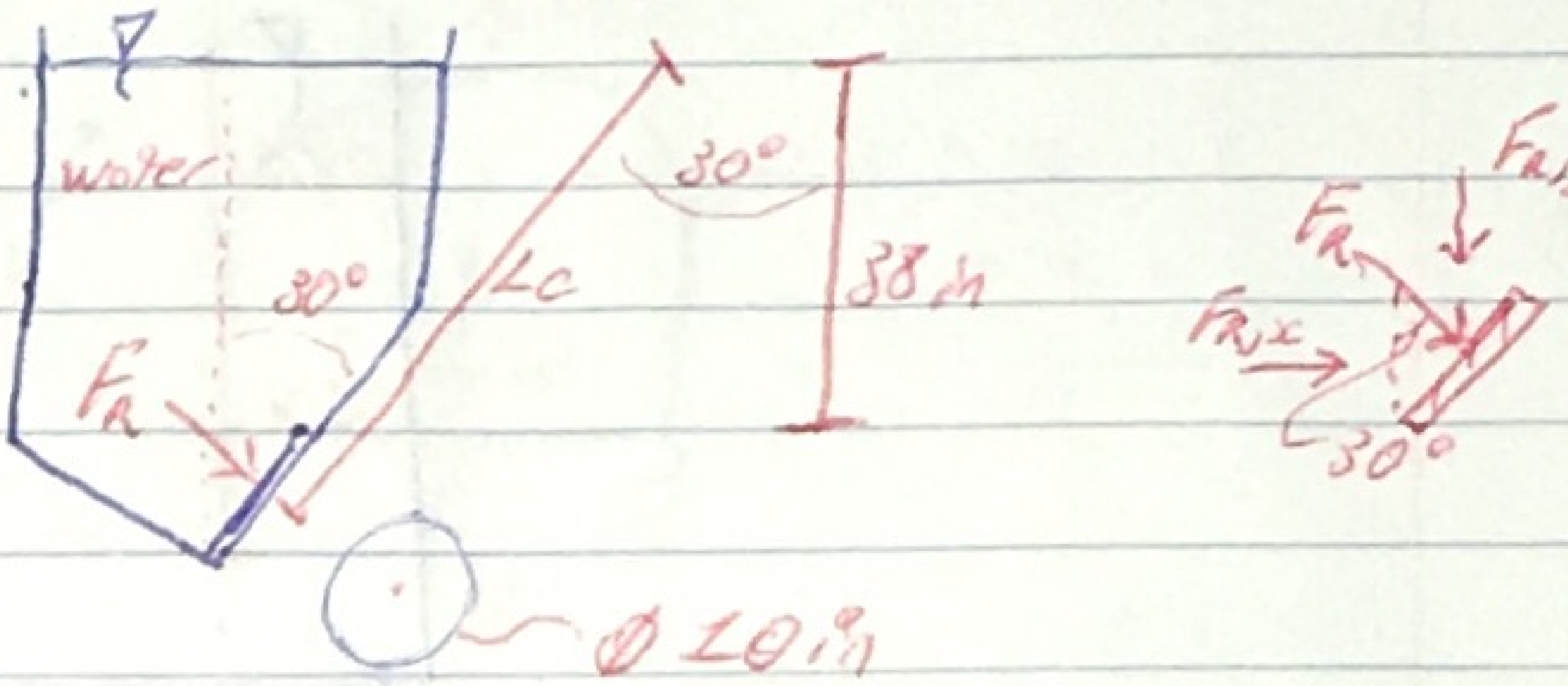
$h_c = L_c \sin 30° = 36.48\,in\, \sin 30 = 18.24\,in = 1.52\,ft$

$F_R = \gamma h_c A = 68.64\, lb/ft^3 \times 1.52\,ft \times \pi \times 20^2 in^2/2 \times 1ft^2/144 in^2$

$= \boxed{455.24\, lb}$

MET330 Team 5 HW2.1

Question 4.42



Given:

Tank contains water - γ_w = ~~9.81 kN/m³~~ 62.4 lb/ft³

Required:

Force of the winch cable to lift the gate.

Calculating the centroid of the gate = D/2 = 10in/2 = 5in

$\therefore L_c = 5in + 38in/\cos 30° = 48.879in$

Calculating moment of Inertia - I_c

$I_c = \pi D^4/64 = \pi \times 10in^4/64$

$\therefore L_p = \frac{I_c}{L_c A} + L_c = \frac{(\pi \times 10in^4/64)}{48.879in \times \pi 10in^2/4} + 48.879in = 49in$

Solving for h_c

$h_c = L_c \cos 30° = 42.330in = 3.528ft$

$F_R = \gamma h_c A = 62.4 lb/ft^3 \times 3.528 ft \times \pi \times 10^2 in/4 \times 1ft/144in^2$

$= \boxed{120.072 lb}$

Solving for the vertical component of the force

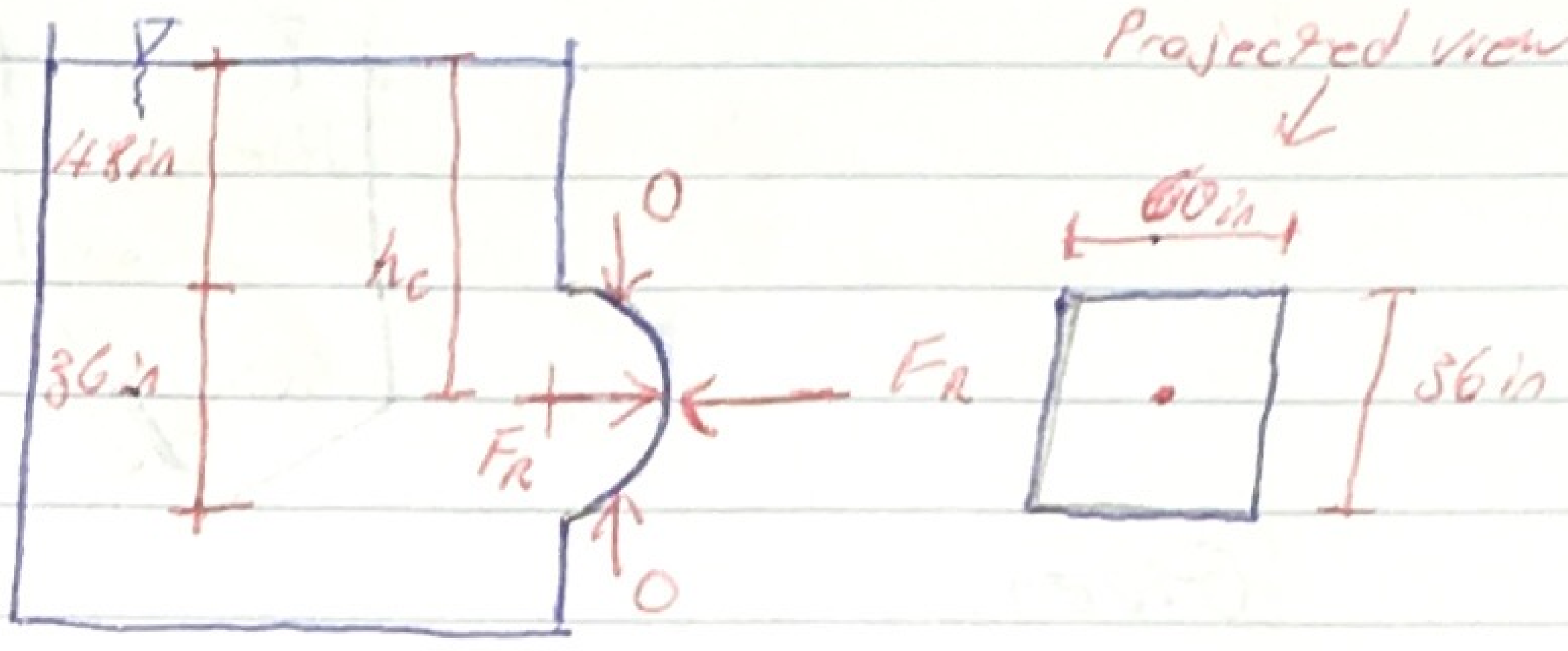
$\cos 30° = \frac{F_R}{F_{R,y}} \therefore F_{Ry} = \frac{F_R}{\cos 30°}$

$\therefore F_{Ry} = \frac{120.072 lb}{\cos 30°} = \boxed{138.647 lb}$

The winch cable exerts 138.647 lb.

MET330 Team 5 HW2.1

Question 4.54



Given:

Tank Contains Alcohol - $S_g = 0.79$

$\gamma_A = 0.79 \times 62.4\ lb/ft^3 = 49.296\ lb/ft^3$

Assuming the vertical components of the forces on the curved surface cancel each other out.

Required:

The horizontal component of the resultant force.

$F_R = \gamma_A h_c A$

$h_c = 48in + 36in/2 = 66in = 5.5ft$

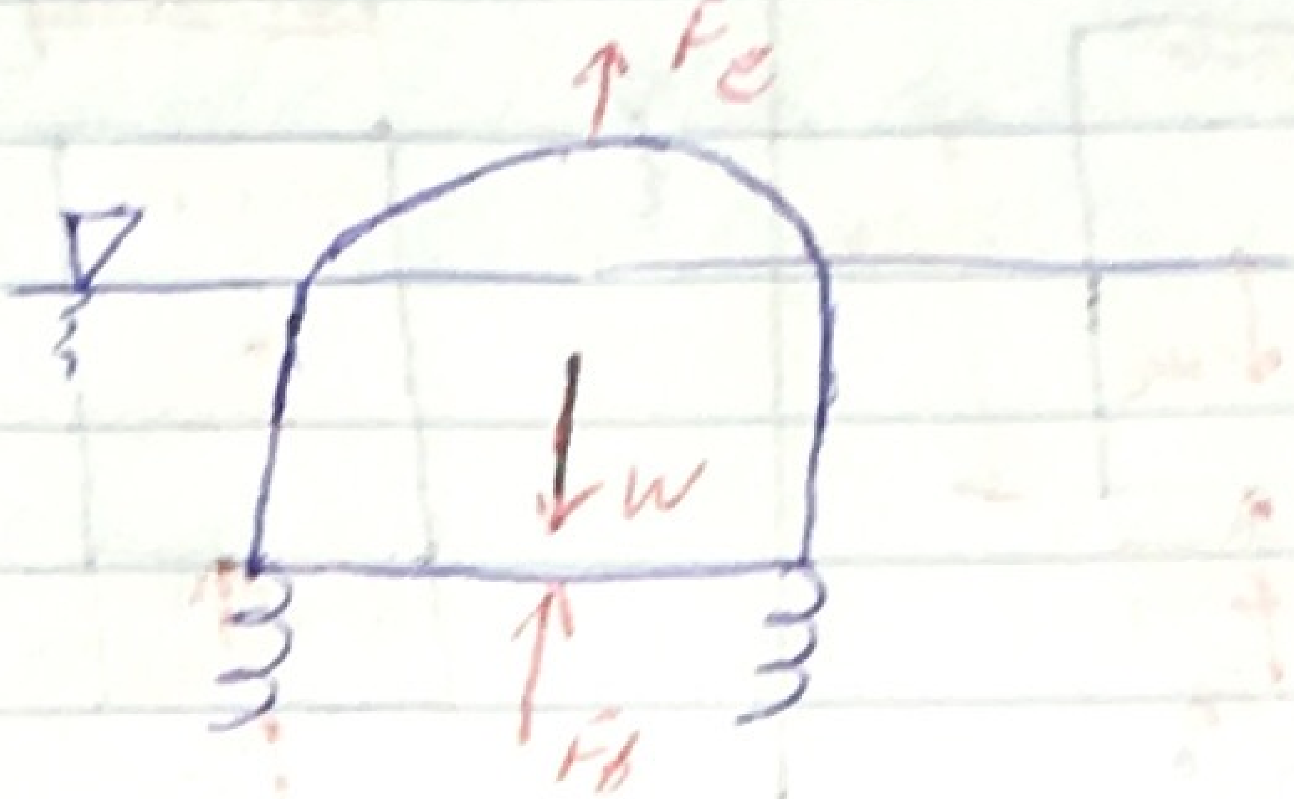
The horizontal component is simply the force acting at the centroid of the area (Projected).

$F_R = \gamma_A h_c A = 49.296\ lb/ft^3 \times 5.5ft \times 36in \times 60in \times 1ft/144in^2$

$= \boxed{4066.92\ lb}$

MET350 Team 5 HW2.1

Question 5.8



Given

The pump is partially submerged in oil - $sg = 0.90$

$\gamma_o = 0.90 \times 62.4\ lb/ft^3 = 56.16\ lb/ft^3$

$W = 14.6\ lb$

$V_d = 40\ in^3$

Required:

Supporting force exerted by the springs.

$\Sigma F_v = 0$; $F_b + F_e - W = 0$

$\therefore F_e = W - F_b$

$= W - \gamma_o V_d$

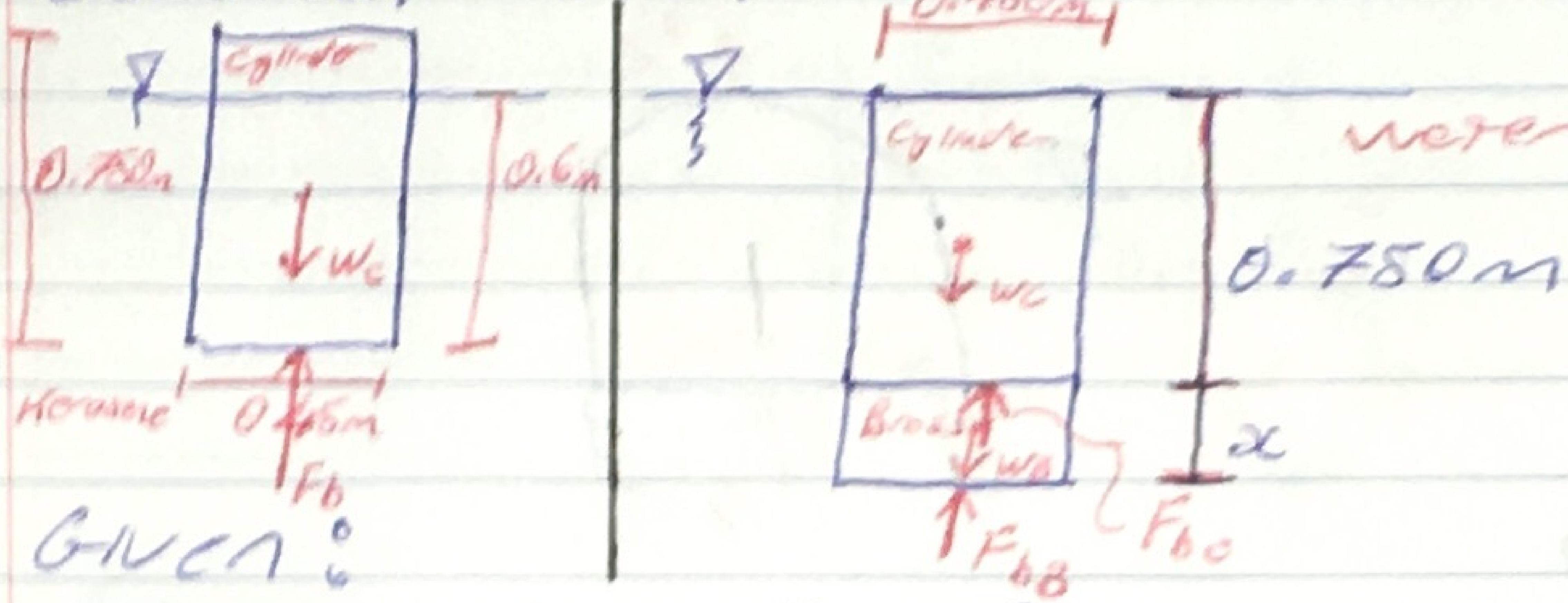
$= 14.6\ lb - 56.16\ lb/ft^3 \times 40\ in^3 \times 1\ ft^3/12^3\ in^3$

$= \boxed{13.3\ lb}$

There are 4 springs, each spring would exert 3.325 lb.

MET330 Team 5 HW2.1

Question 5.24



Given:

Water @ 95°C $- \gamma_w = 9.44\ KN/m^3$

γ_B - Brass Plate $= 84.0\ KN/m^3$

Kerosene @ 25°C $- \gamma_K = 8.07\ KN/m^3$

Required:

The thickness of the Brass $- x$

consider FBD #1

$\sum F_v = 0;\ F_b - W_c = 0$

$\therefore W_c = F_b = \gamma_K V_d$

$= 8.07\ KN/m^3 \times \pi/4 \times 0.45^2_m \times 0.6m$

$= 770.087\ N$

Consider FBD #2

$\sum F_v = 0;\ F_{bc} + F_{bB} - W_c - W_B = 0$

Solving for F_{bc}

$F_{bc} = \gamma_w V_d = 9.44\ KN/m^3 \times \pi/4 \times 0.45^2 \times 0.75m$

$= 1126.025\ N$

Solving for F_{bB}

$F_{bB} = \gamma_w V_d = 9.44KN/m^3 \times \pi/4 \times 0.45^2 \times x_m$

$= 15588.269x\ N/m$

Solving for W_B

$W_B = \gamma_B V_B = 84.0KN/m^3 \times \pi/4 \times 0.45^2 \times x_m$

$= 138709.17x\ N/m$

MET330 Team 5 HW 2.1

Q5.24 Cont'd

$\therefore 1126.025\,N + 15588.269x\,N/m + 770.087\,N$

$= 138709.17x\,N/m$

$\Rightarrow 355.938\,N - 123120.901x\,N/m = 0$

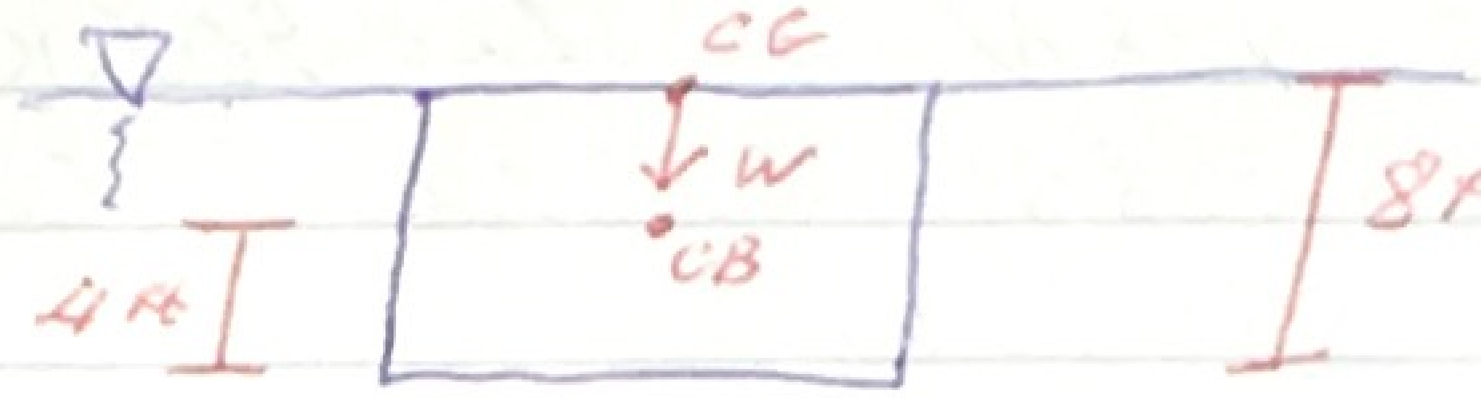
$\Rightarrow 355.938\,N = 123120.901x\,N/m$

$x = \dfrac{355.938\,N}{123120.901\,N/m}$

$= \boxed{0.00289\,m}$

MET350 Team 5 HW2-I

Question 5.41



Given:
The platform's CG is 8 ft from the bottom.
It's CB must be at the centroid of Vd = 4 ft
Platform depth = 50 ft

Required:
The platforms Metacenter must be located in order to find out if it floats or, sinks. or is stable.

$MB = I / V_d$

$I = \frac{hB^3}{12} = \frac{4\,ft \times 20^3\,ft}{12} = 2666.667\,ft^4$

$V_d = 4\,ft \times 20\,ft \times 50\,ft = 4000\,ft^3$

$\therefore MB = \frac{2666.667\,ft^4}{4000\,ft^3} = 0.667\,ft$

The metacenter is 0.667 ft above the center of buoyancy and below the center of gravity.
This means that the ~~vess~~ platform will be unstable and sink

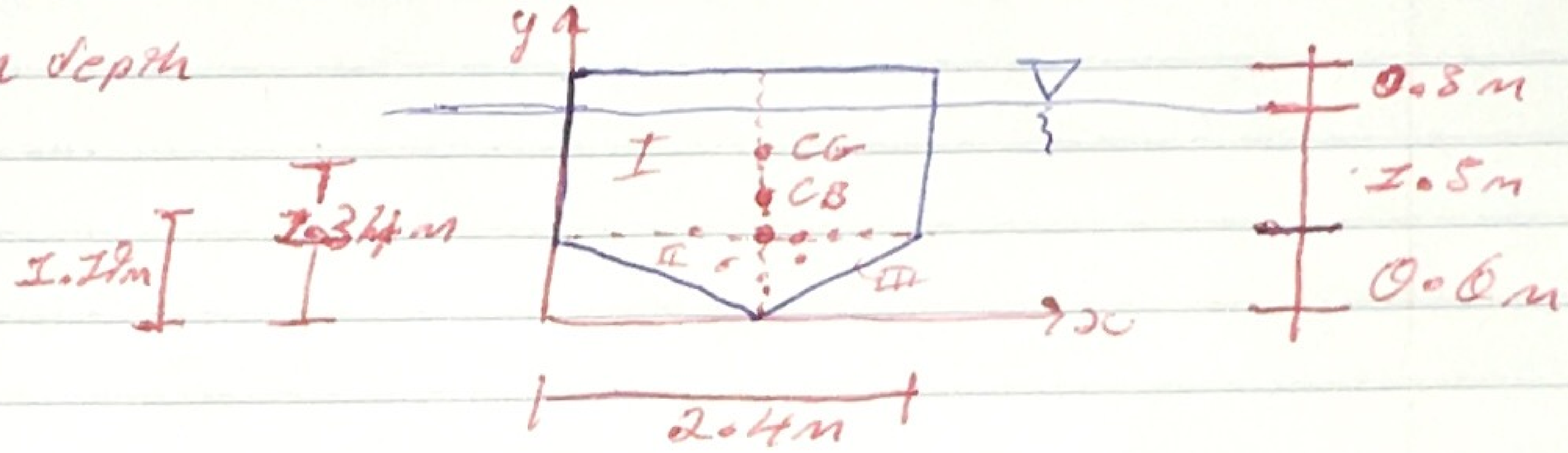
$Y_{mc} = Y_{cb} + MB = 4\,ft + 0.667\,ft$
$= 4.667\,ft$

$Y_{mc} < Y_{cg}$; **unstable**

MET350 Team 5 HW2.1

Question 5.61

5.5m depth



Given:
dimensions shown in F.B.D.
Required:
Is the boat stable.

	x_i	y_i	A_i	A_ix_i	A_iy_i
I	1.2	1.5	4.32	5.184	6.48
II	0.8	0.4	0.36	0.288	0.144
III	1.6	0.4	0.36	0.64	~~0.4~~ 0.144
			5.04	6.112	6.768

$\bar{y} = \frac{\Sigma A_i y_i}{\Sigma A_i} = \frac{6.768 m^3}{5.04 m^2} = 1.34 m \; Y_{CG}$

calculating $\bar{y}$ for displaced volume

$\bar{y} = \frac{~~5.148~~}{~~5.04~~} = \frac{5.148 m^3}{4.32 m^2} = 1.19 m \; Y_{CB}$

$I_c = \frac{BH^3}{12} + \frac{BH^3}{36} = \frac{2.4m \times 1.5^3 m}{12} + \frac{2.4m \times 0.6^3 m}{36}$

$= 0.6894 m^4$

$MB = \frac{I_c}{V_d} = \frac{0.6894 m^4}{4.32 m^2 \times 5.5 m} = 0.0067 m$

$Y_{mc} = Y_{cb} + MB = 1.19 m + 0.0067 m$
$= 1.197 m$

$Y_{mc} < Y_{CG}$, unstable

The topics covered by this assignment are Buoyancy and Stability, and Forces due to Static Fluids. After reading the chapters and reviewing the solved problems posted on Canvas it was evident that these topics relied heavily on skills learnt in Solid Mechanics and Statics.

The ability to solve problems relating to the stability of floating vessels such as boats and being able to compute the forces exerted on tanks of various shapes by the fluids they contain are two examples of skills learnt from these topics.