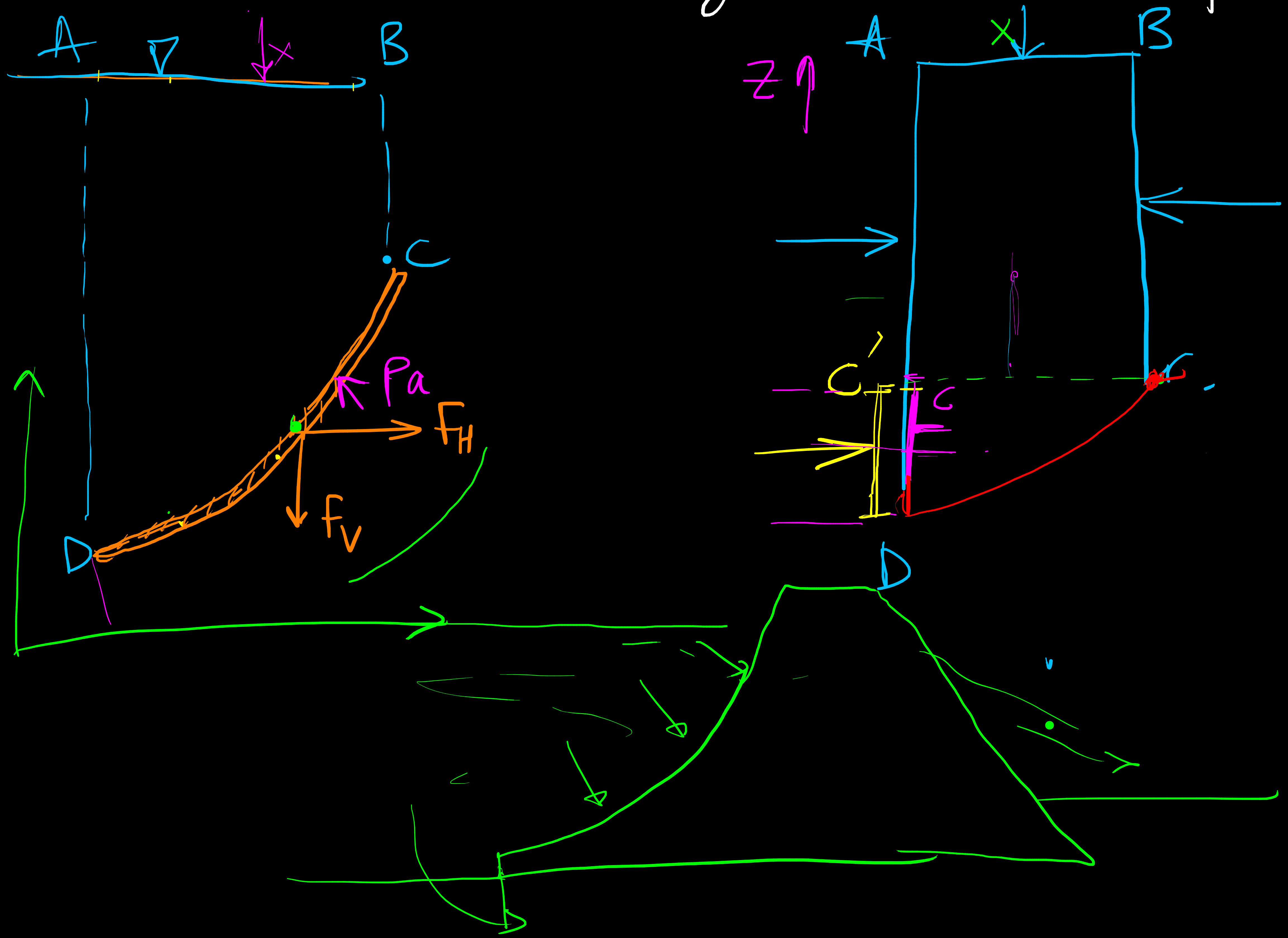
Forces acting on curved surfaces



F Balance in X dir

AC' & BC cancel

$F_{C'D} - F_H = 0$

$\boxed{F_H = F_{C'D}}$

F balance in y

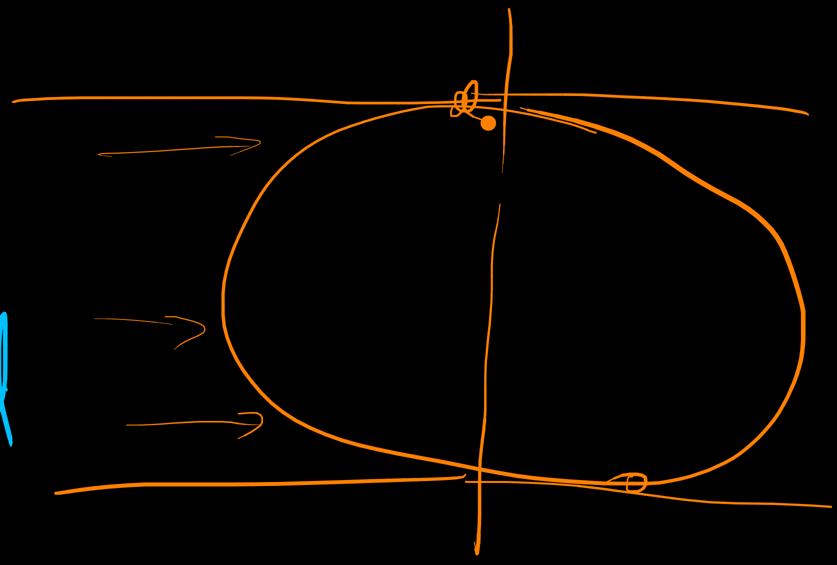
$W - F_V = 0$

$\boxed{F_V = W}$

Buoyancy

Archimedes

Body immersed ⟶ weight of displaced fluid

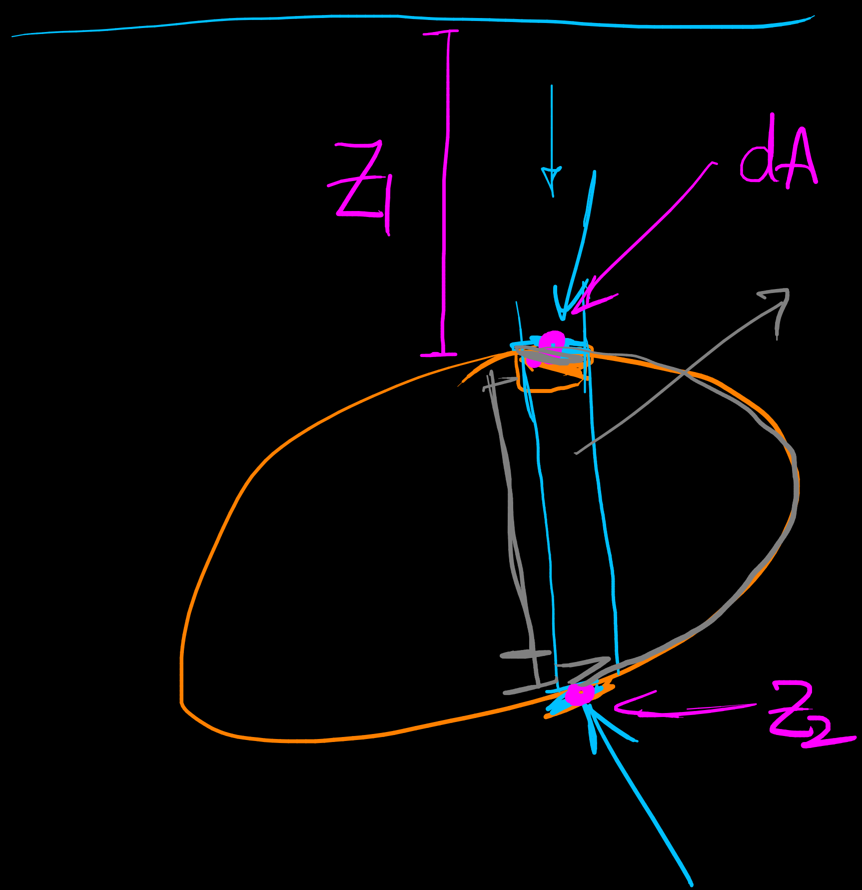


$$F_B = \int_{body} (p_2 - p_1)\, dA$$

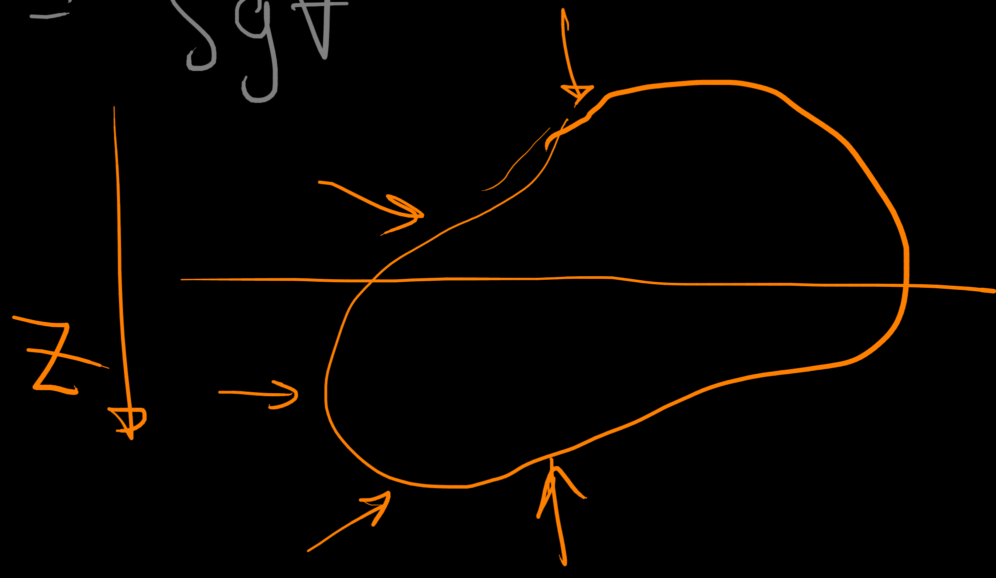
$$= \int (\rho g z_2 - \rho g z_1)\, dA$$

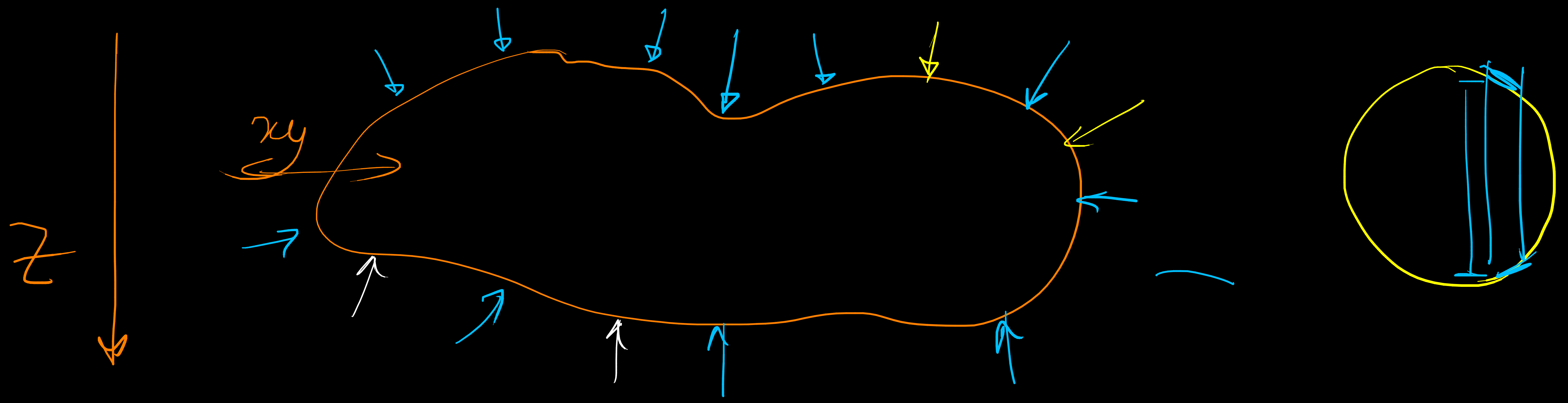
$$= \rho g \int (z_2 - z_1)\, dA = \rho g \int dA\, \Delta z$$

$$= \rho g \forall$$



$$F_B = \underbrace{\boxed{\rho g \forall}}_{\text{weight of displaced fluid}}$$

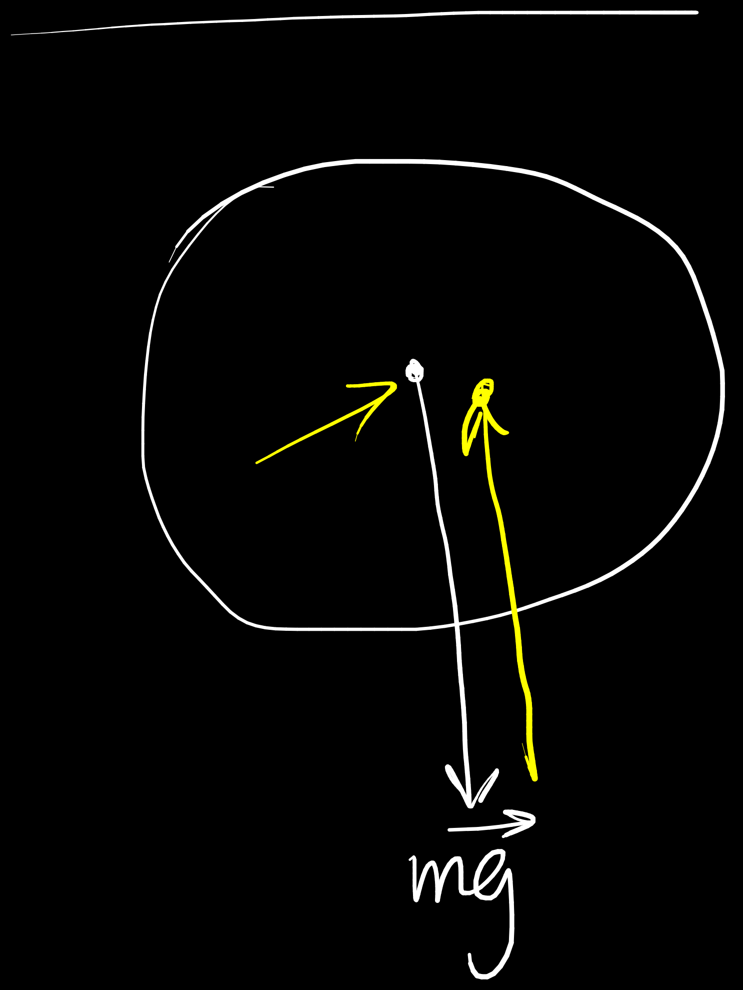


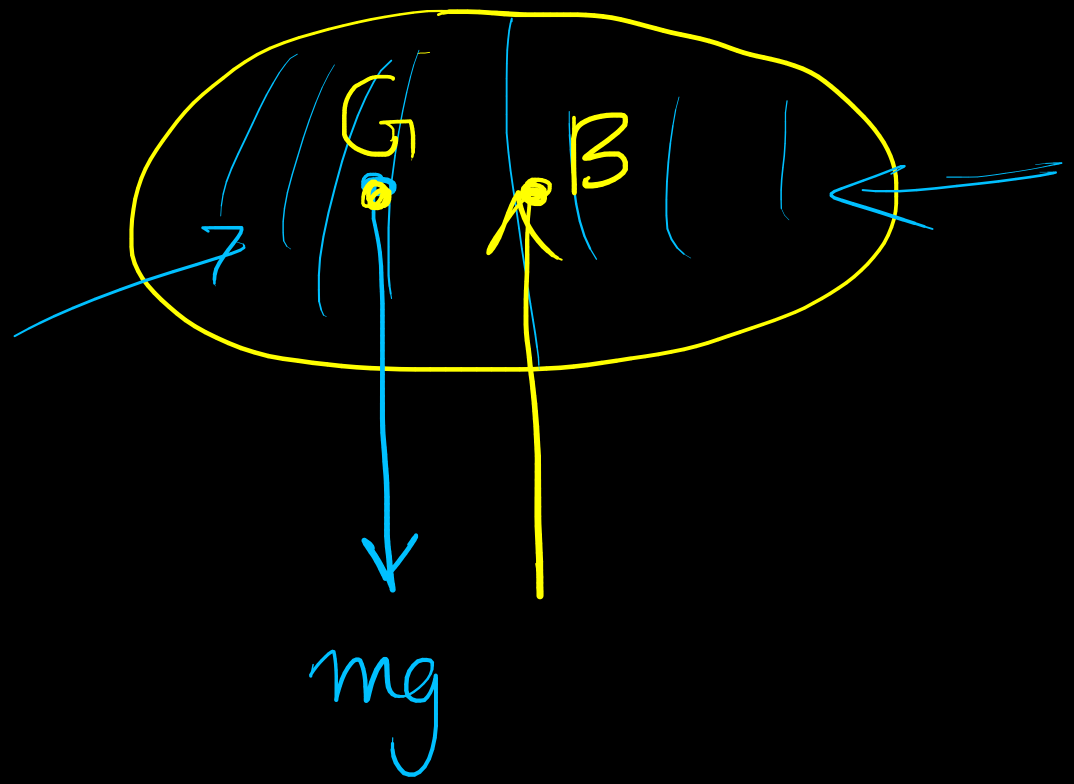


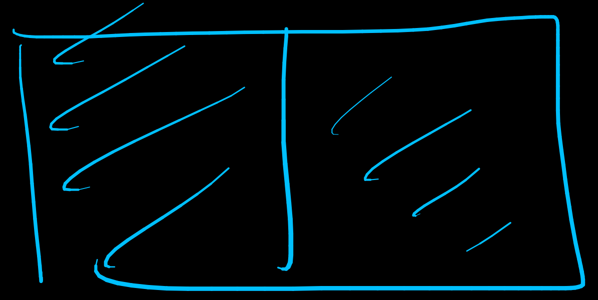
z
xy

Partially submerged body

Where does buoyancy act







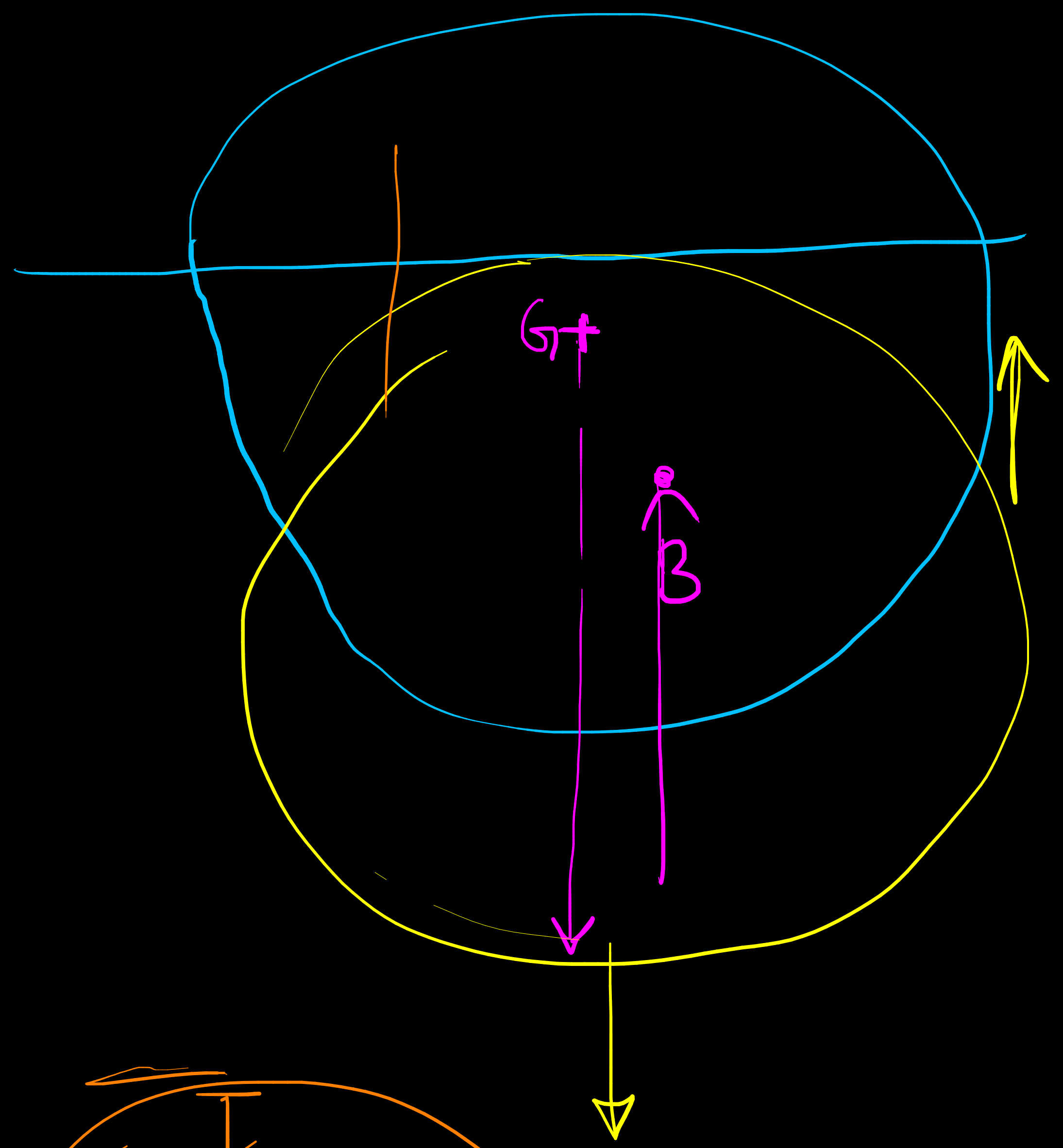
Q1. whether partial / completely ?

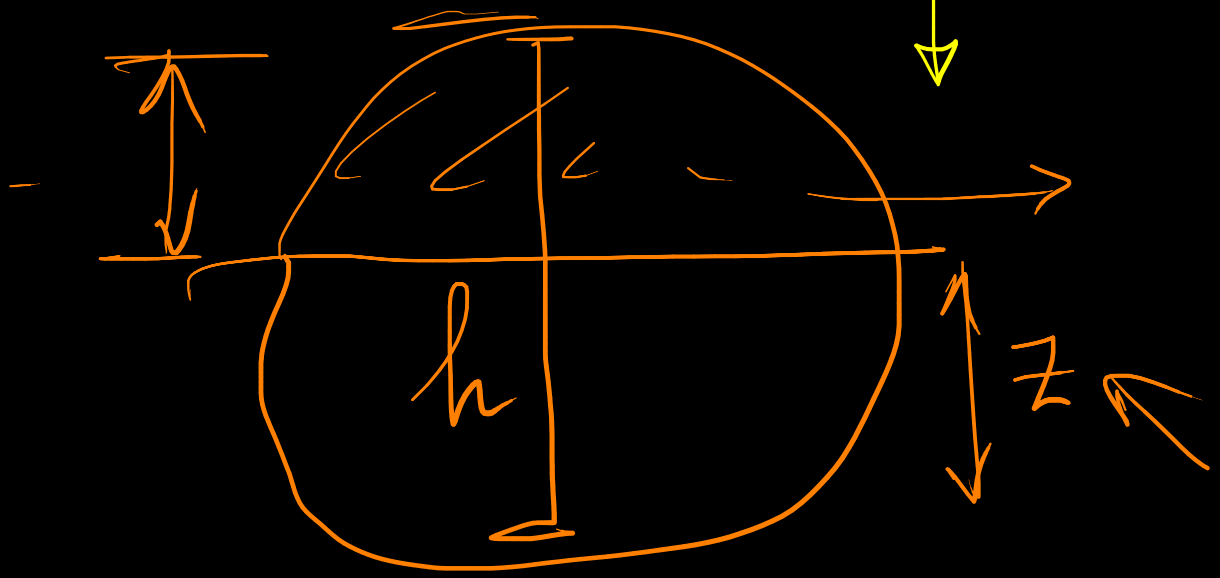
→ Assume full submerge

$$\boxed{F_B > mg}$$

$$F_B = mg$$

$$F_B < mg$$



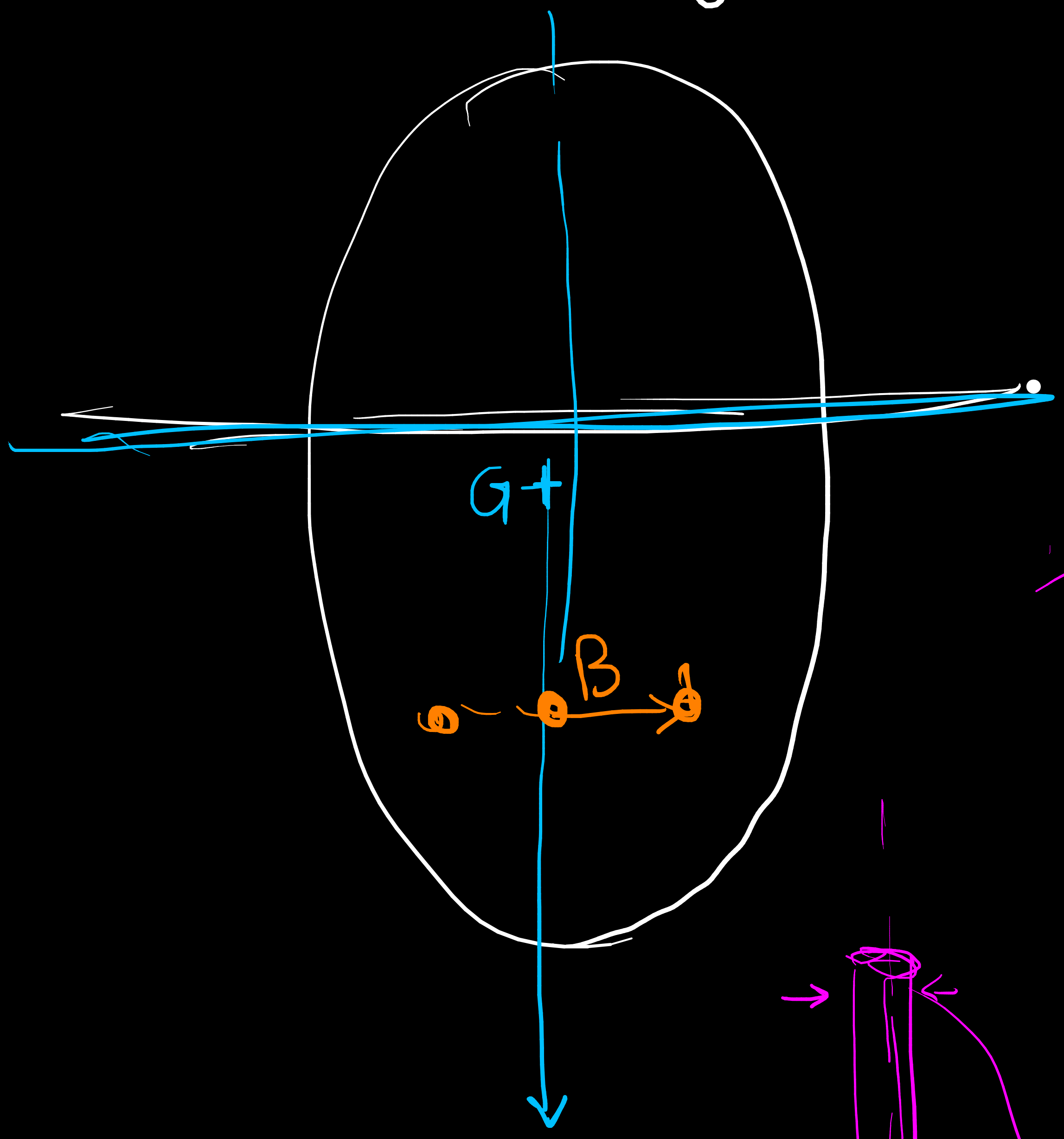


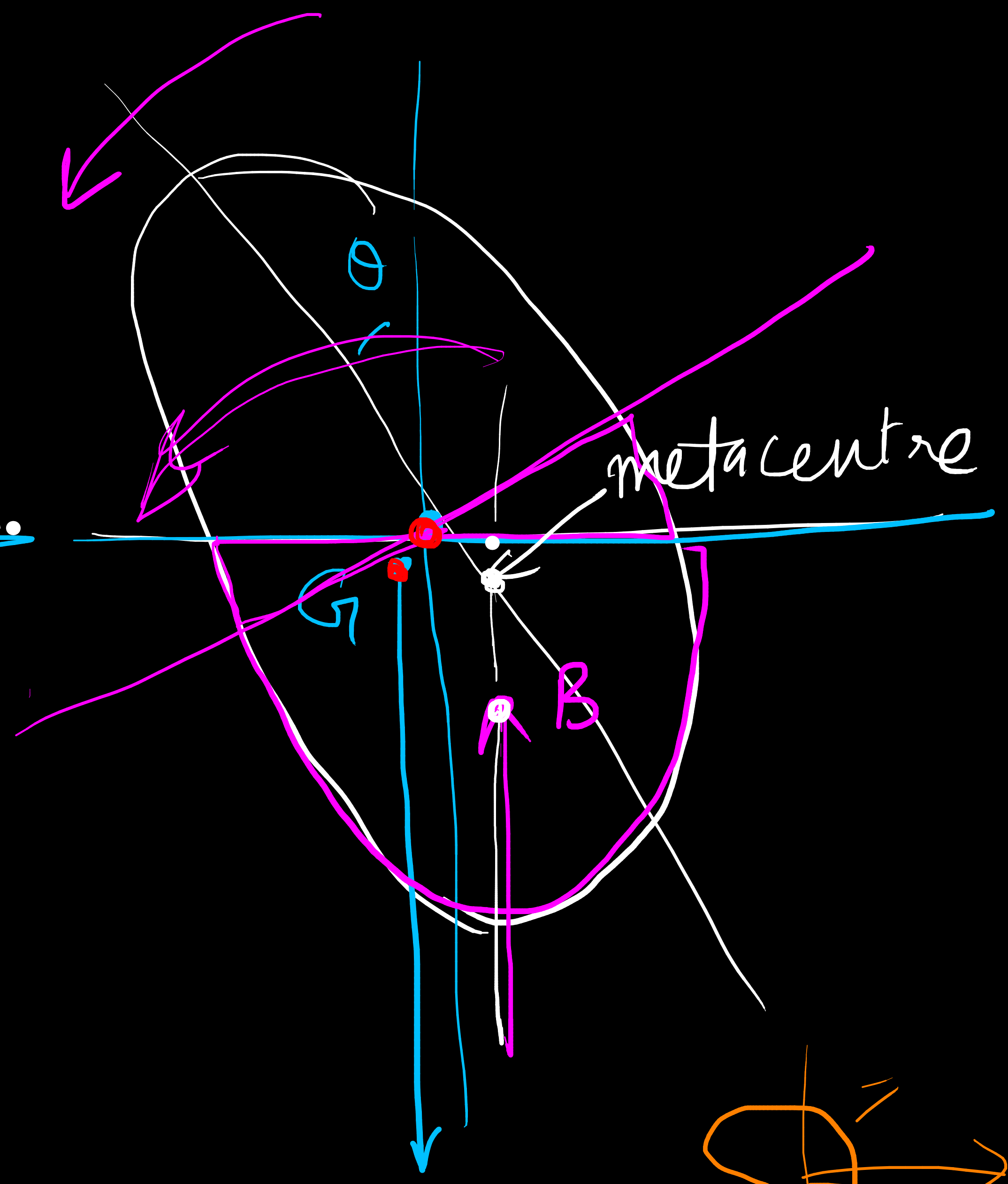
$$(Z \times A) \times (\rho_w g) = W$$

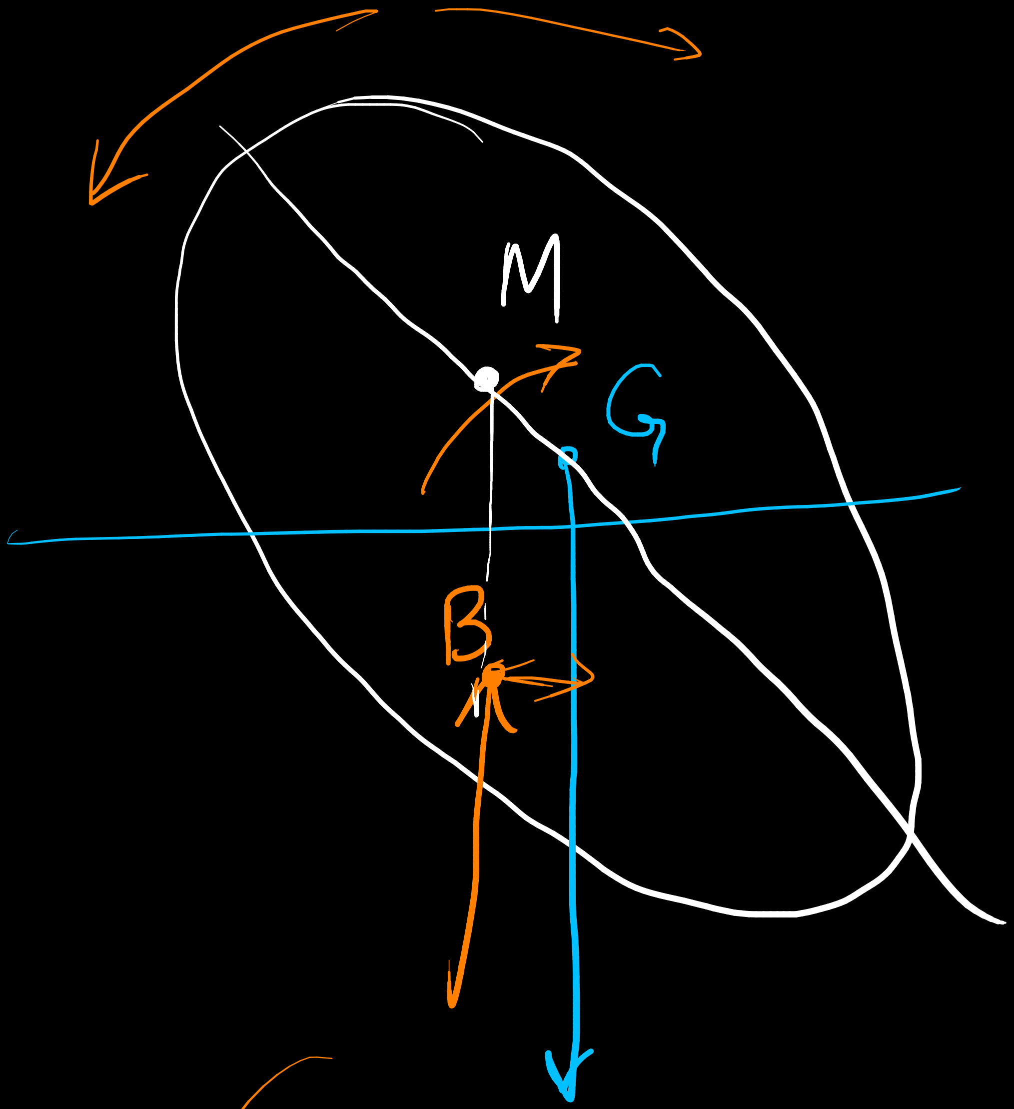
$$Z = \frac{W}{A \rho_w g}$$

$$h - Z$$

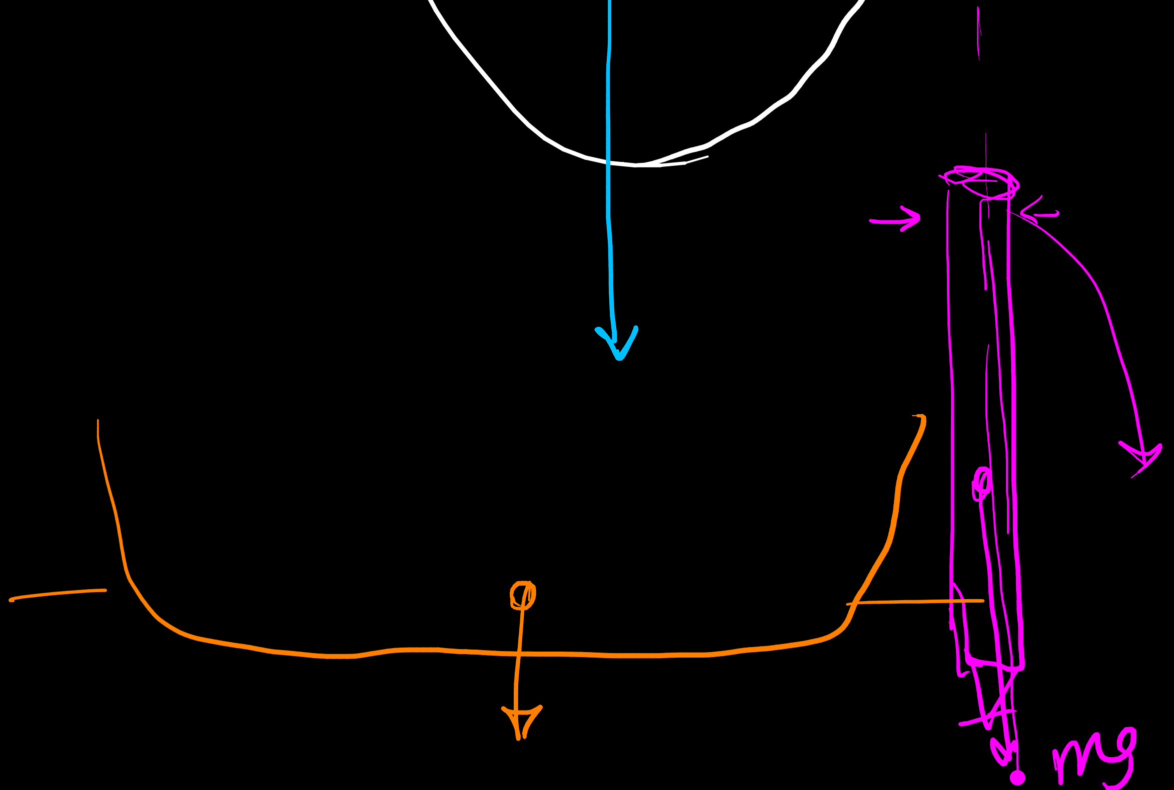
Stability





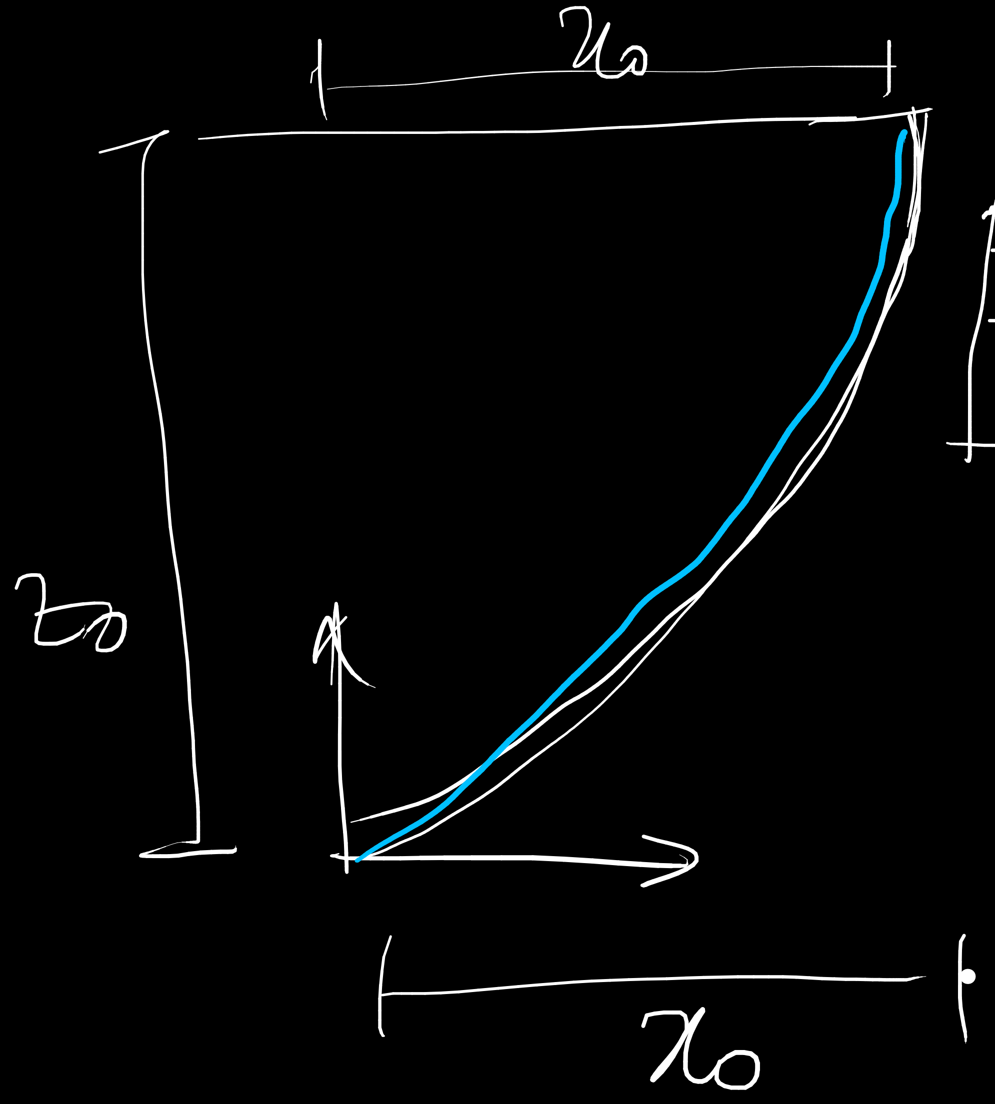


Restoring moment



Unstable

Inflatable



$$\boxed{\frac{z}{z_0} = \left(\frac{x}{x_0}\right)^2}$$

$b = 50$

$x_0 = 10$

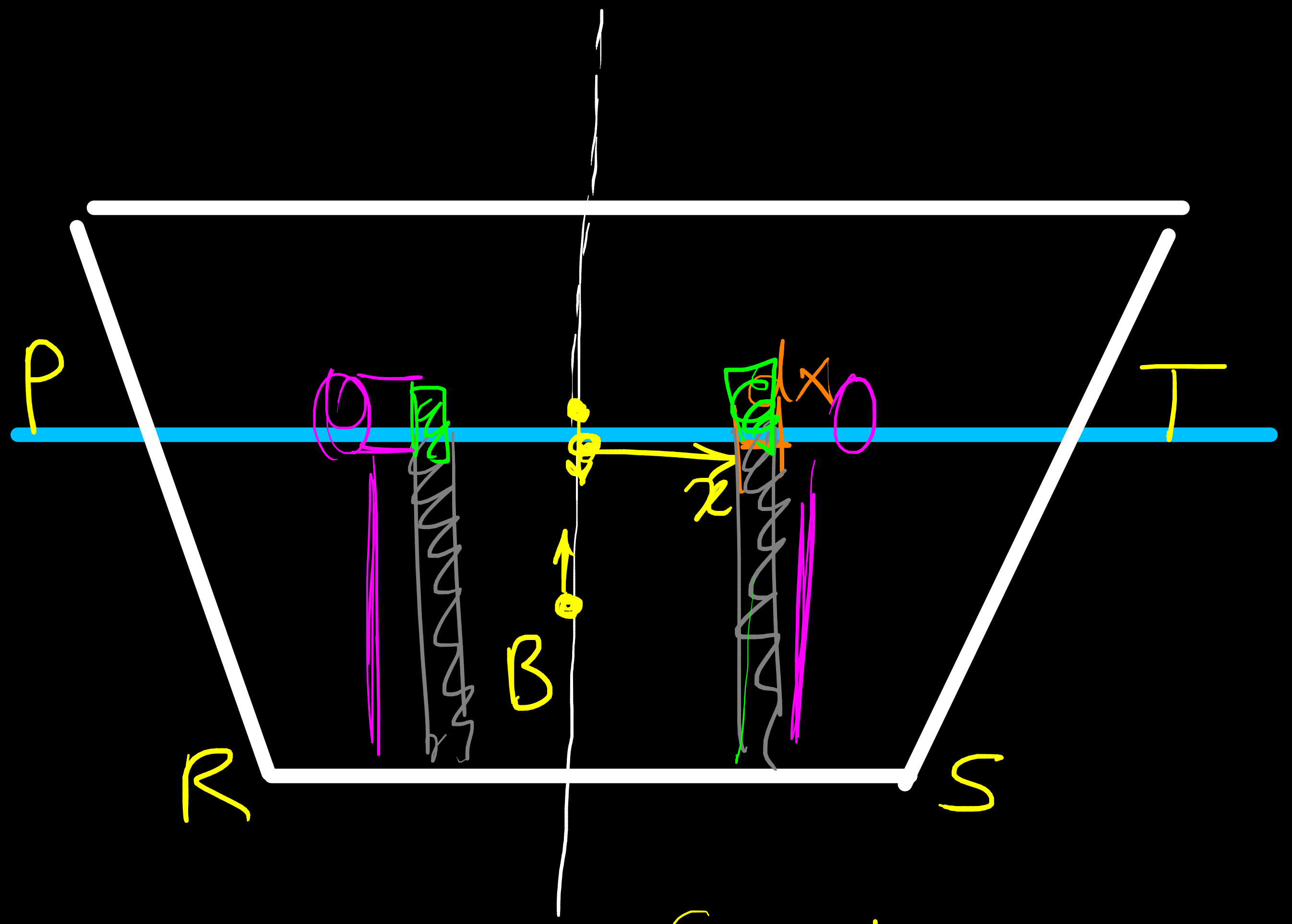
$z_0 = 24$

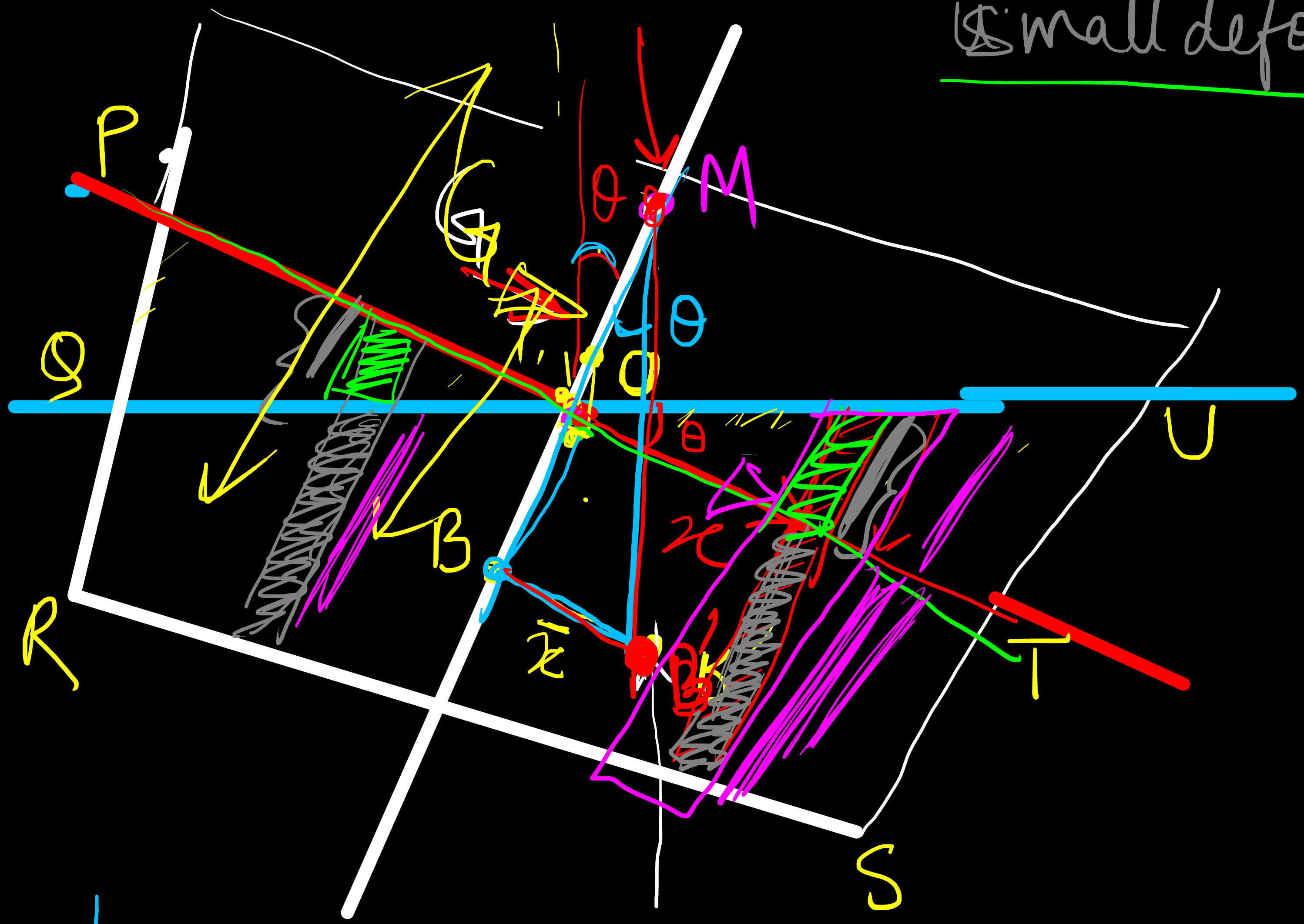
$\rho g = 62.4$

$F_H =$

$F_V =$

Small deformation





$$\bar{x} \times V_{sub} = \int_{QOUSR} x\,dV$$

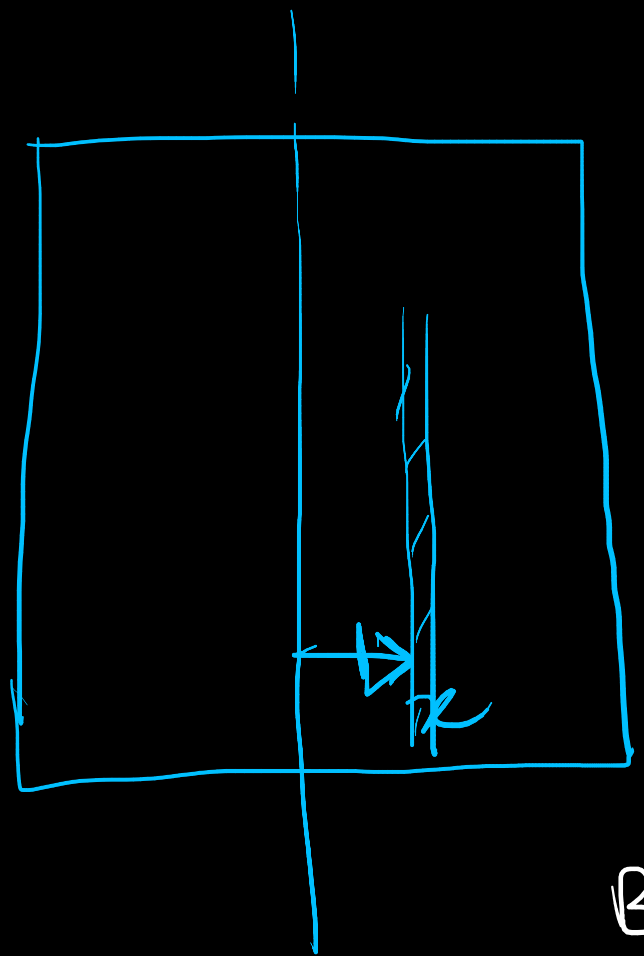
$$\frac{\bar{x}}{MB} = \tan\theta$$

$$= \int_{PTRS} x\,dV + \int_{UOT} x\,dV - \int_{POQ} x\,dV = \boxed{\int x \times L\,dx\; x\tan\theta - \int x L\,dx\,(-x\tan\theta)} = \int x^2 \tan\theta\,dx L + \int x^2 \tan\theta\,dx L$$

D

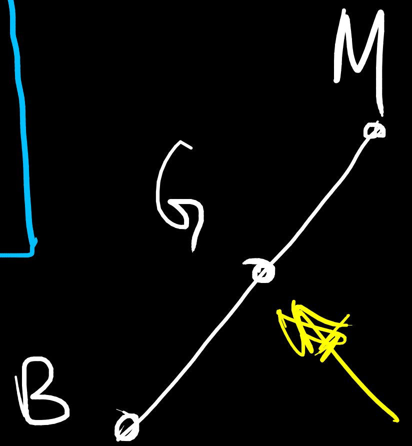
$$\bar{x} V_{sub} = \int x^2 \tan\theta \, dx \, L = \tan\theta \underbrace{\int x^2 \, dA_{waterline}}_{\text{Second moment}}$$

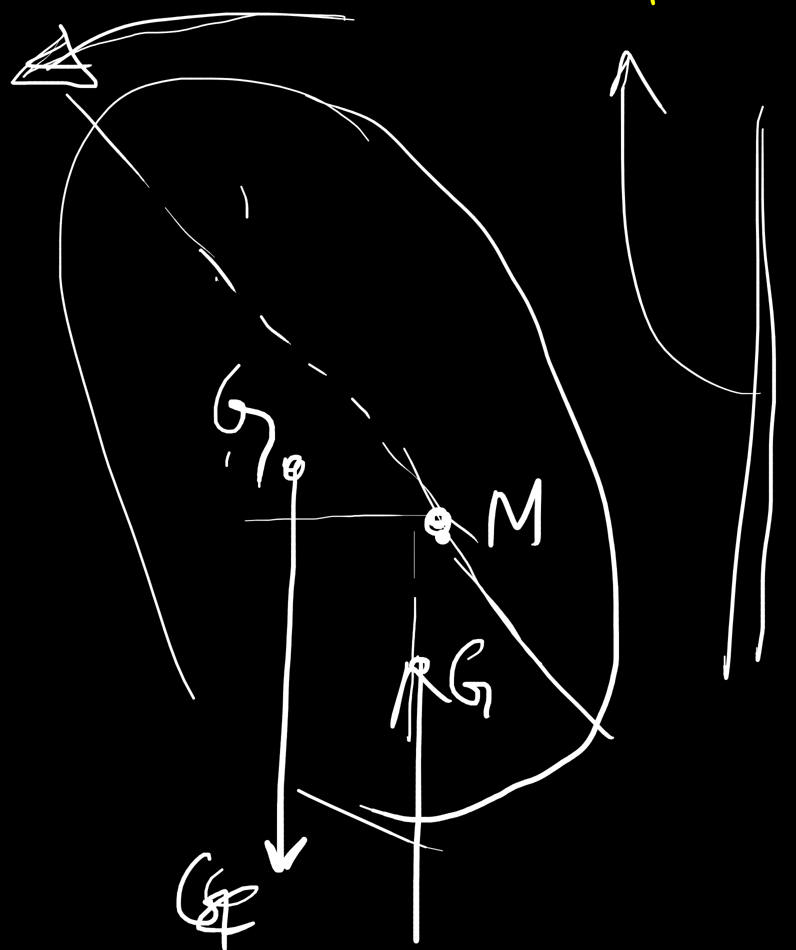
$$\bar{x} V_{sub} = \tan\theta \, I_o$$



$$\frac{\bar{x}}{\tan\theta} = \frac{I_o}{V_{sub}} = \underline{MB} = MG + GB$$

GB





M lies above G

Restoring

M lies below G

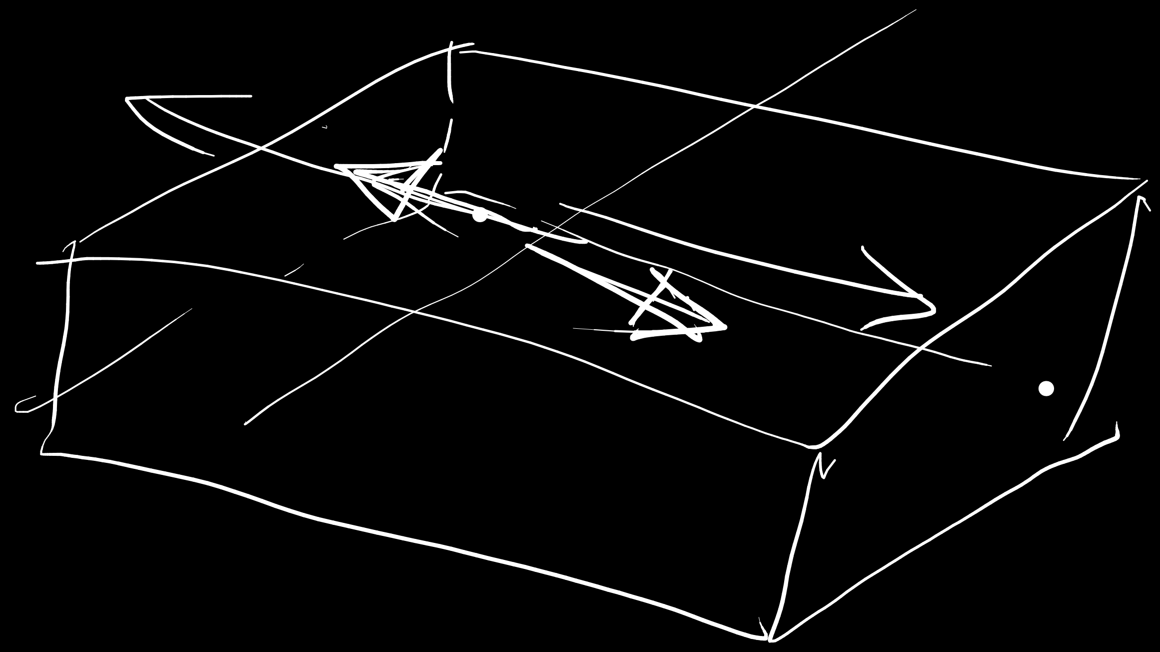
overturn

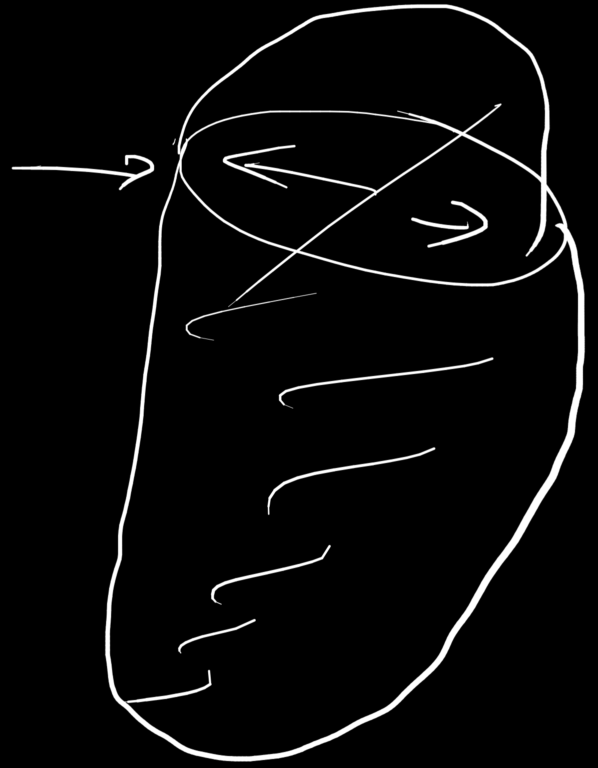
$$MG = \frac{I_o}{V_{sub}} - \underline{GB}$$

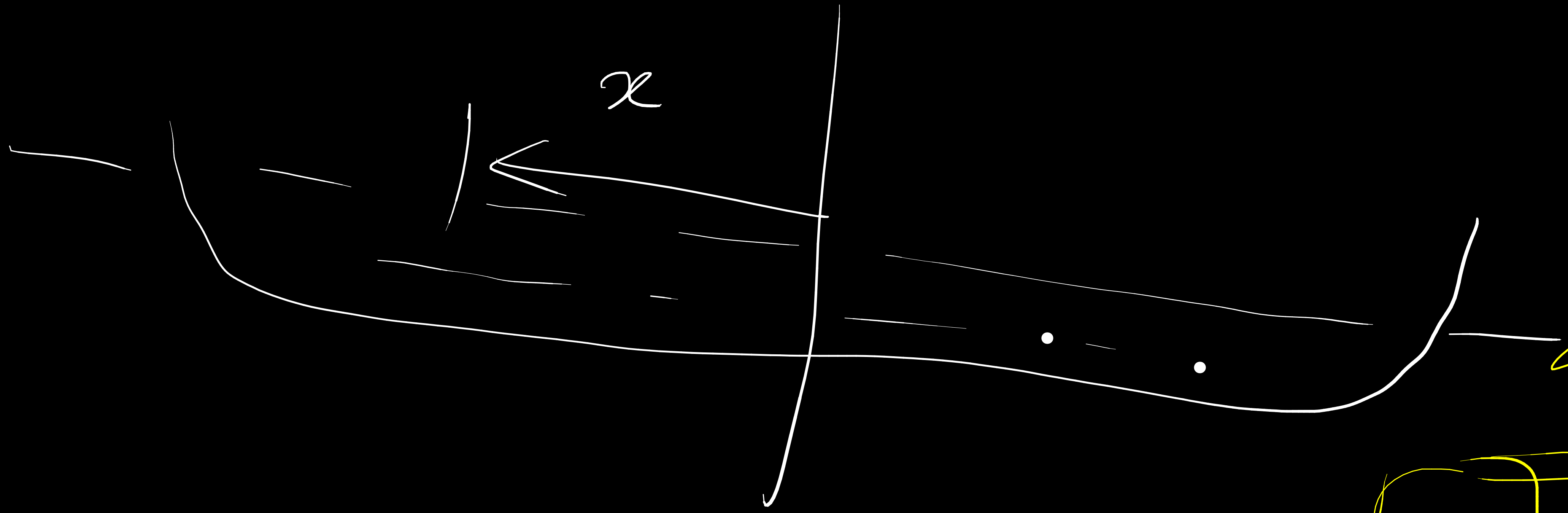
(+ve) stable

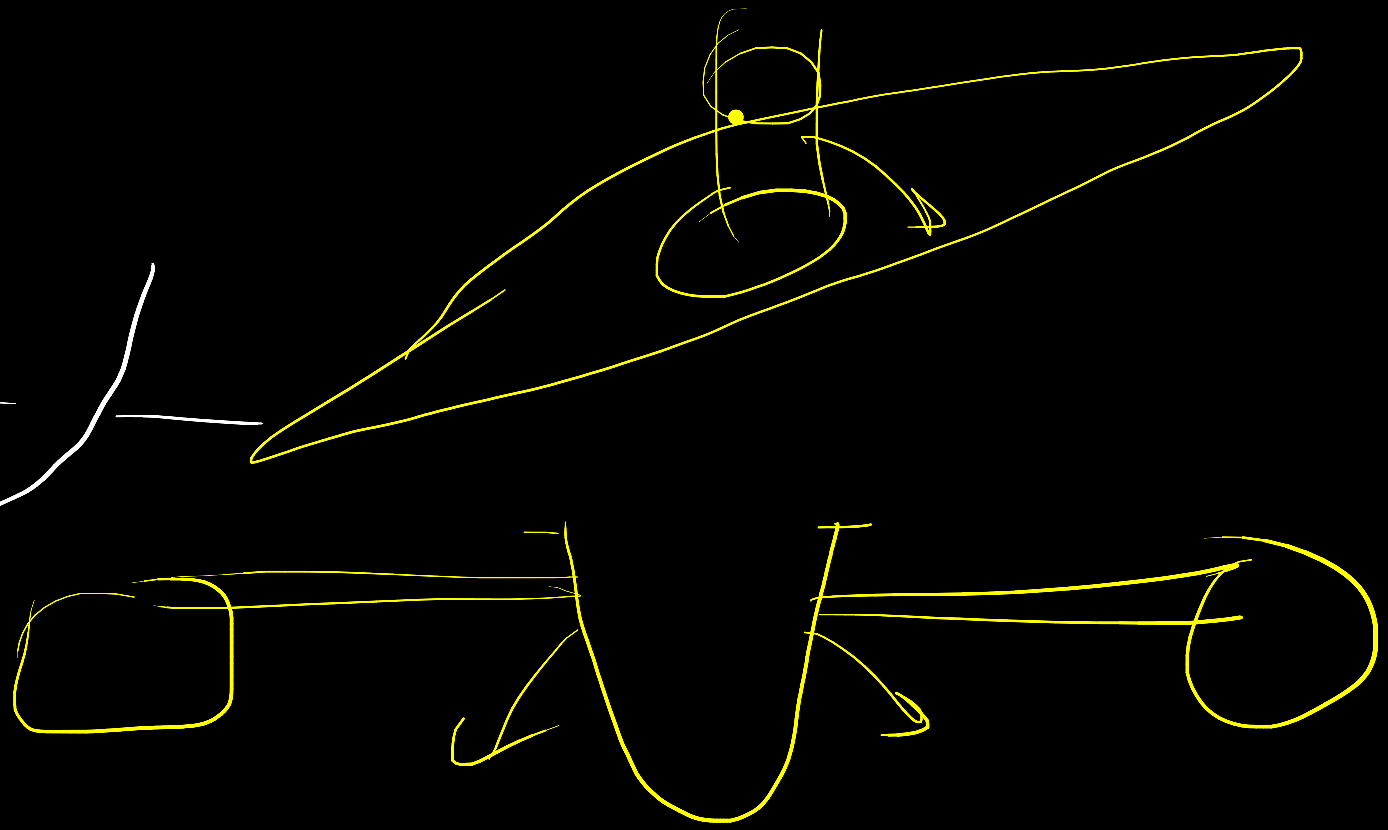
$$\boxed{MG = \frac{I_o}{V_{sub}} - GB}$$

large I_o



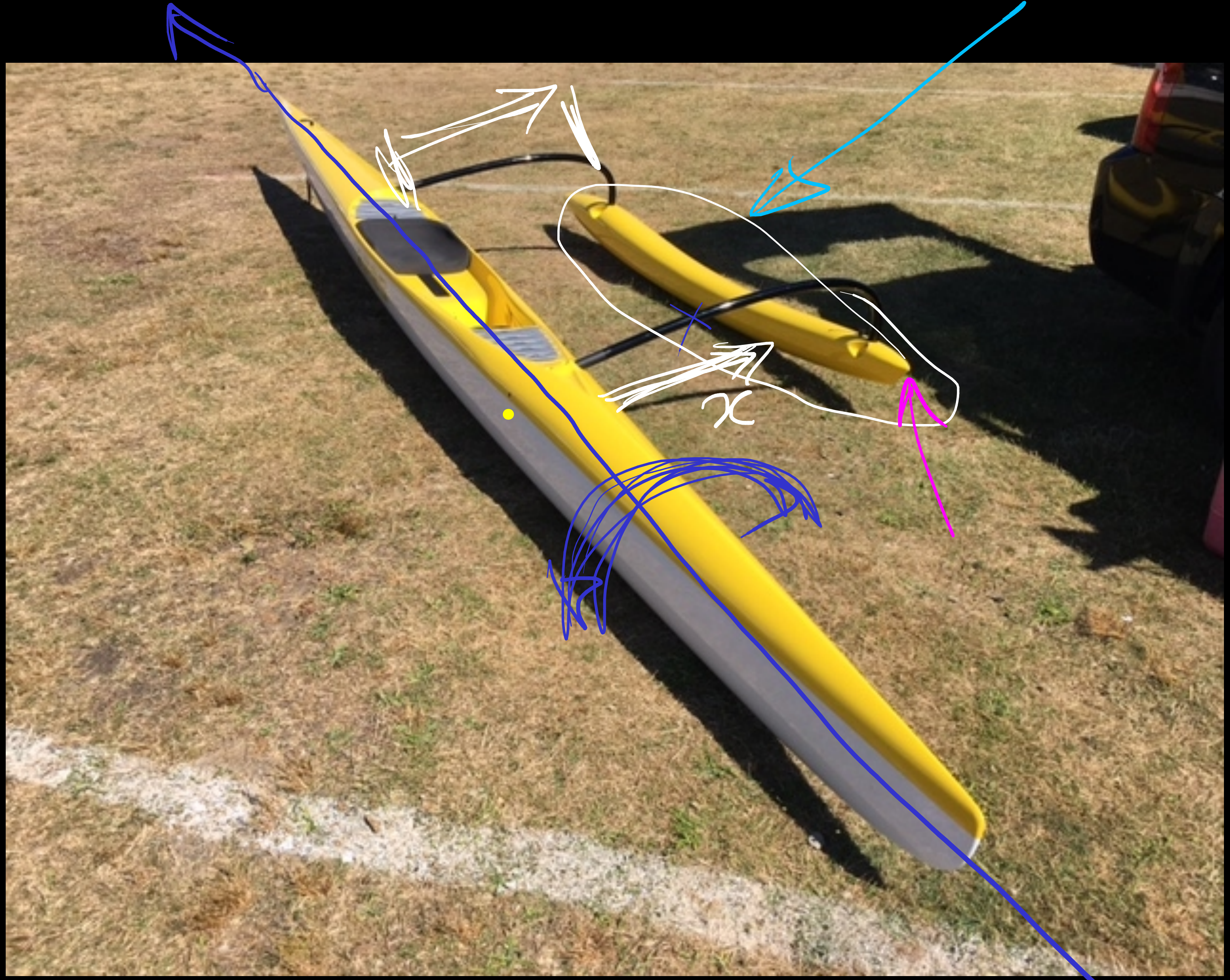


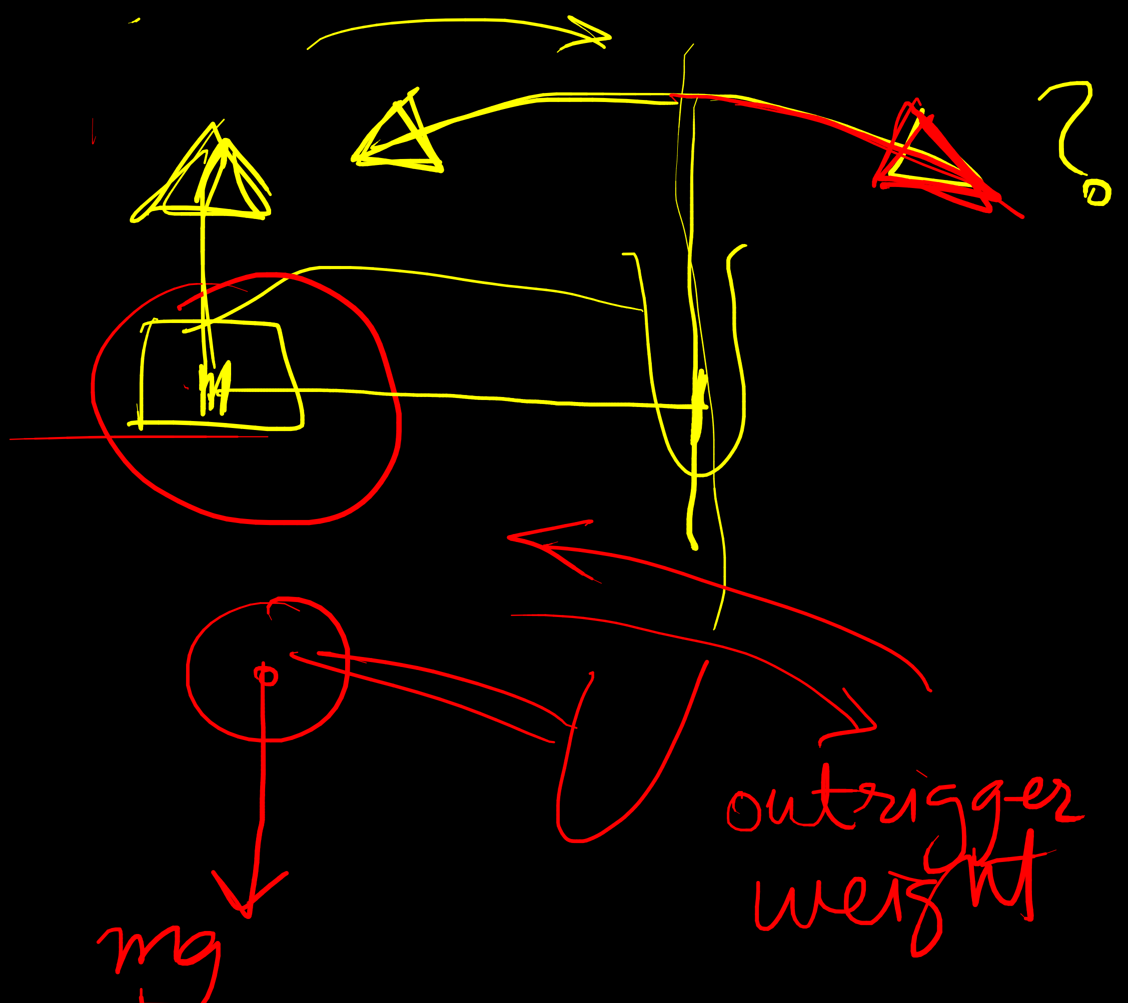




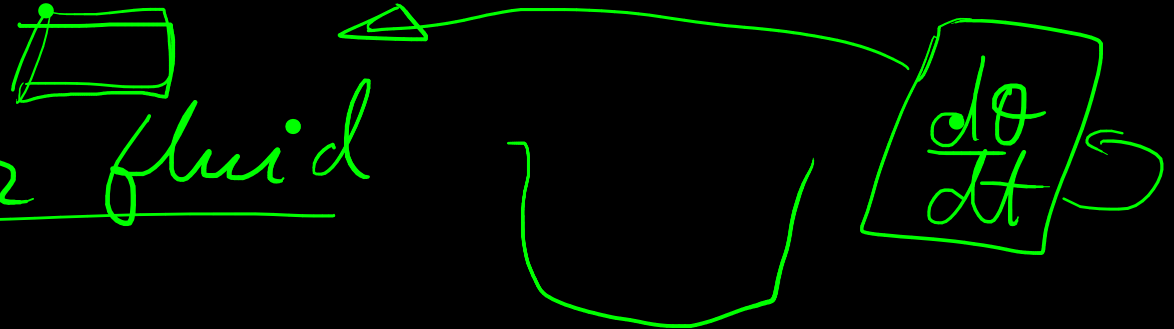
$$\underline{I_o} = \int \underline{x^2} \, dA_{ourigge}$$

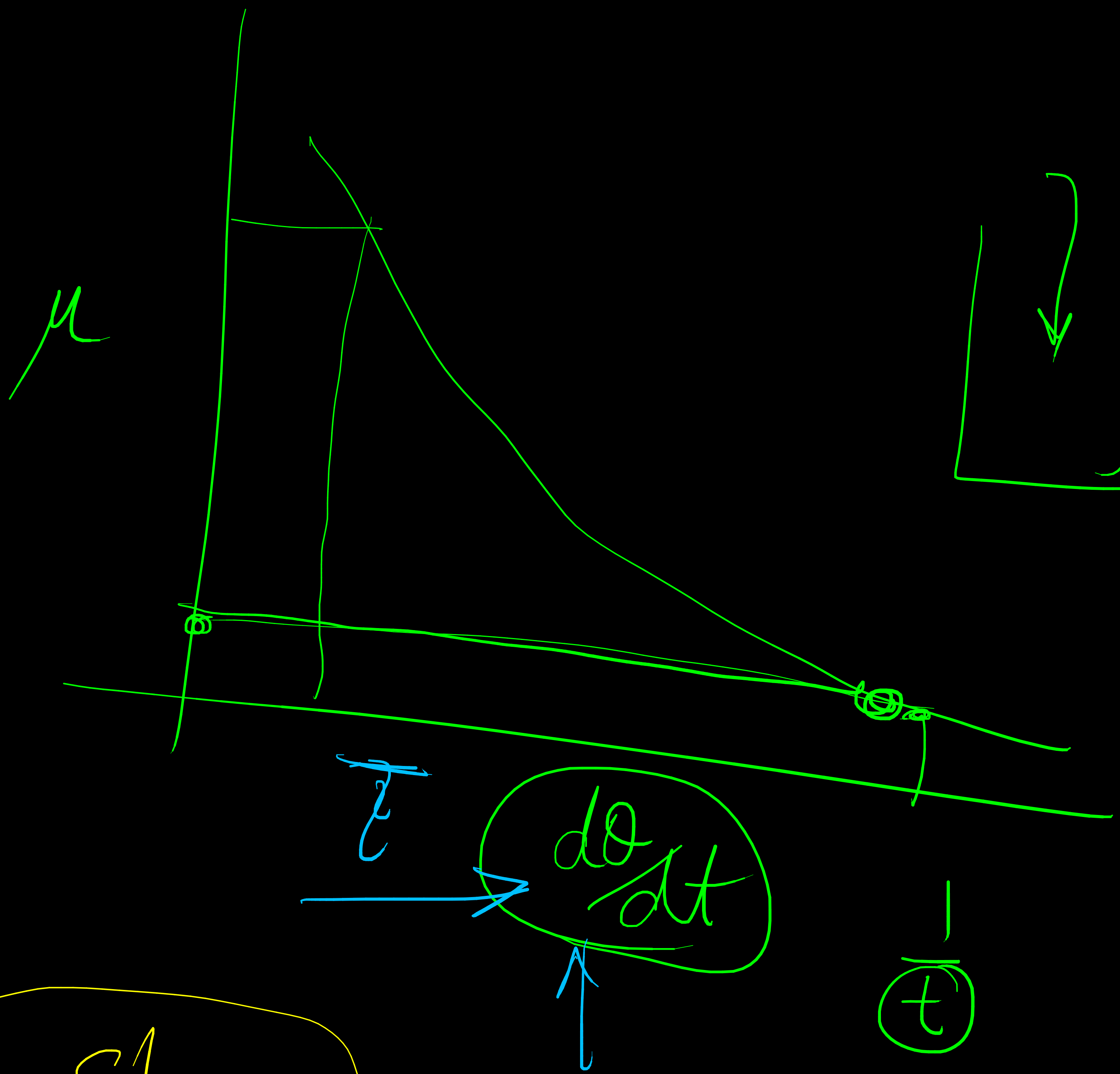
Why 1 outrigger?

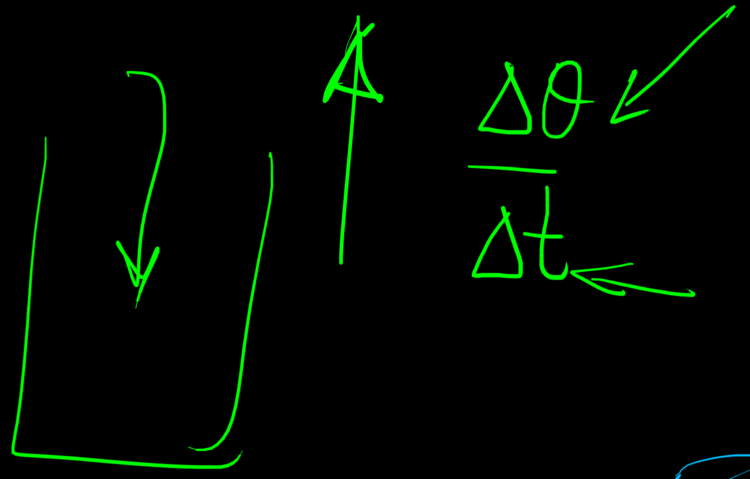


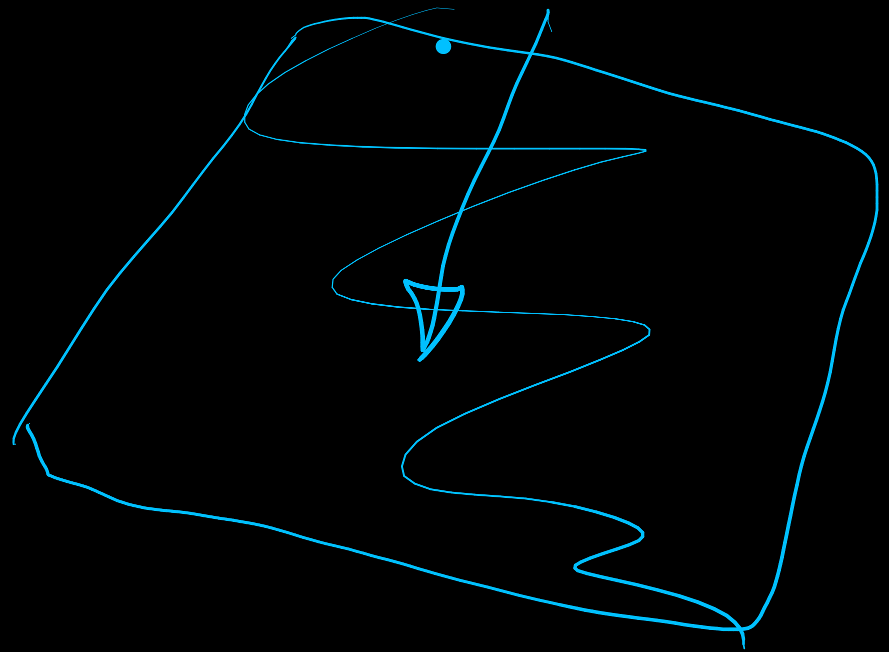


Boger fluid









Shear thinning

Rheology

Corn-starch + water

Shear thickening