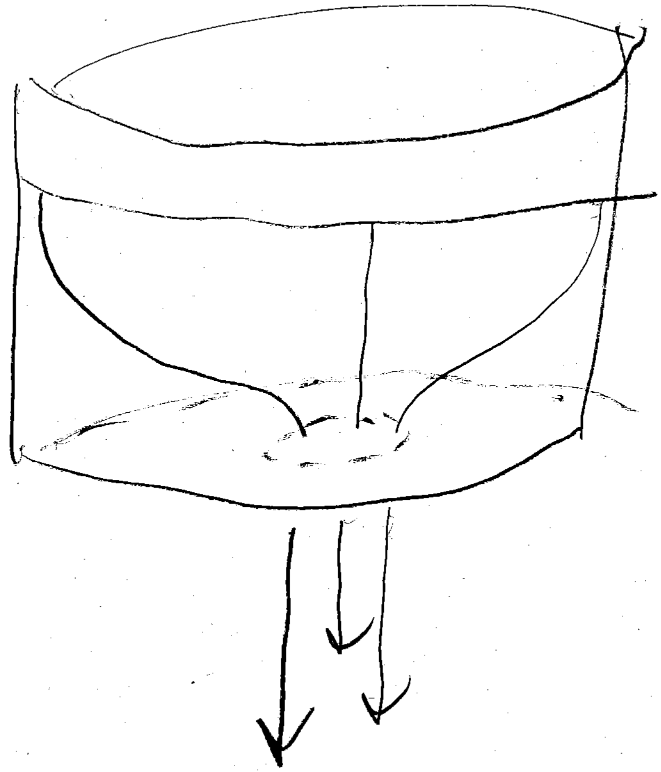
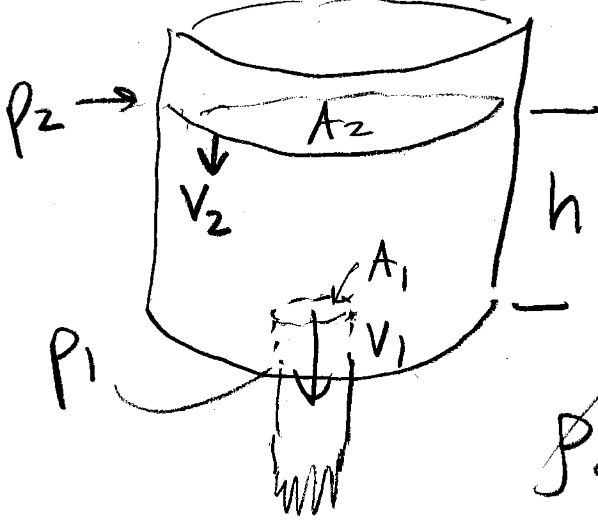
"Stream Line": path of a tiny partcle in fluid.



Cut a hole in the bottom..




$P_1 = P_2$ !!!

$v_1 \neq v_2$

$$\cancel{\rho} g y_1 + \frac{1}{2}\cancel{\rho} v_1^2 = \cancel{\rho} g y_2 + \frac{1}{2}\cancel{\rho} v_2^2$$

$$v_1^2 - v_2^2 = 2gh$$

Incompressible $\quad A_1 v_1 = A_2 v_2$

$$v_2 = \left(\frac{A_1}{A_2}\right) v_1$$

$$\left(1 - \left(\frac{A_1}{A_2}\right)^2\right) v_1^2 = 2gh$$

$$v_1^2 = \frac{2gh}{1 - \left(\frac{A_1}{A_2}\right)^2}$$

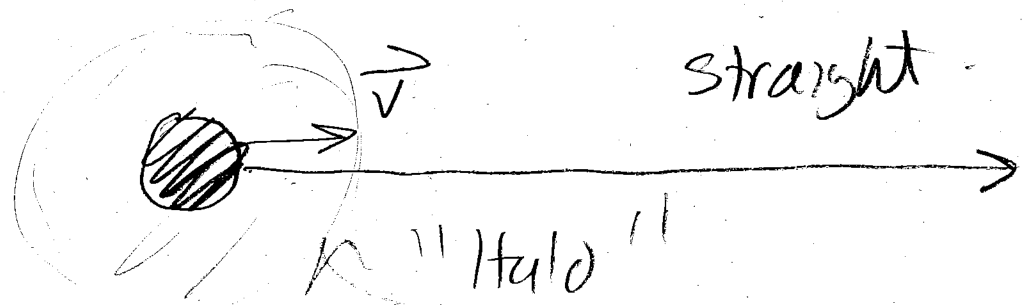
As $A_1/A_2 \to 0$,

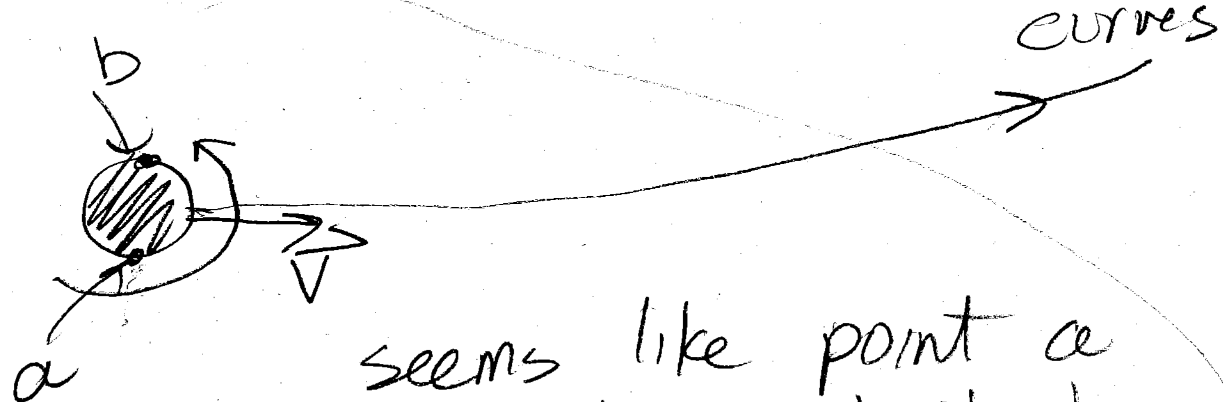
$$v_1^2 \simeq 2gh$$

(Torricelli's Principle) $\rightarrow$ = same speed$^2$ a dense object would reach!

# Curve balls (ping pong)

## From above:

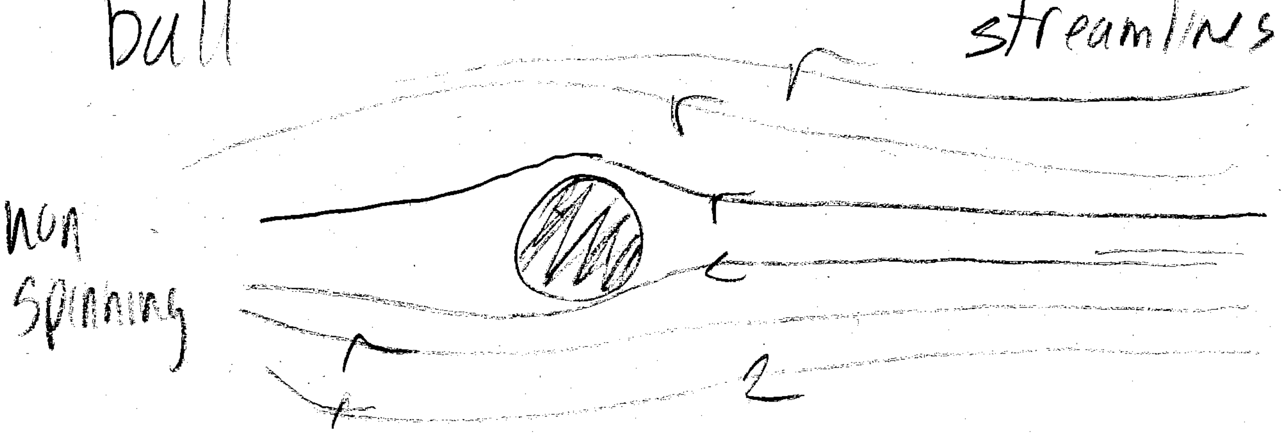


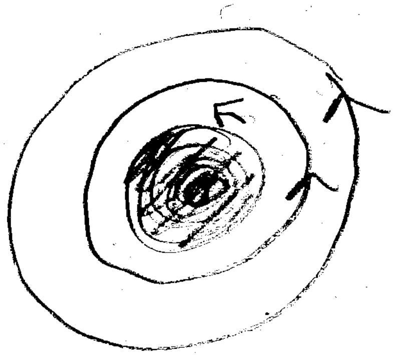

seems like point a has higher velocity!

key point: some air is dragged along with ball

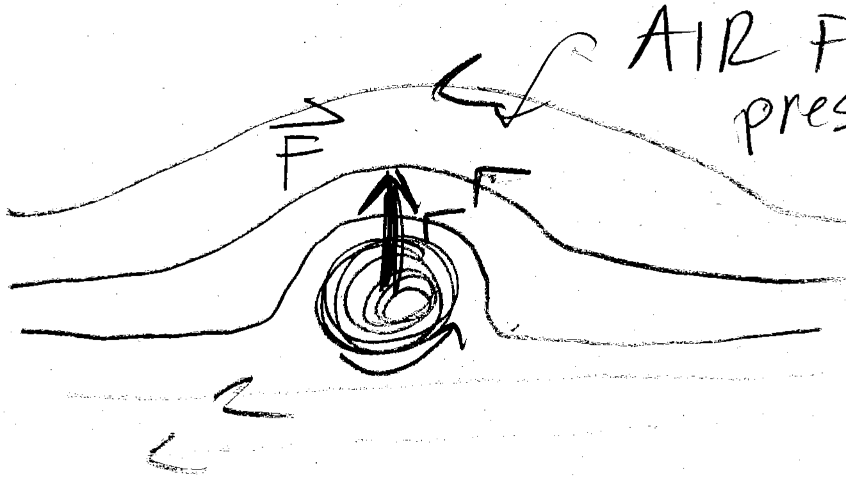
Jump into rest frame of ball



Ball + air spinning



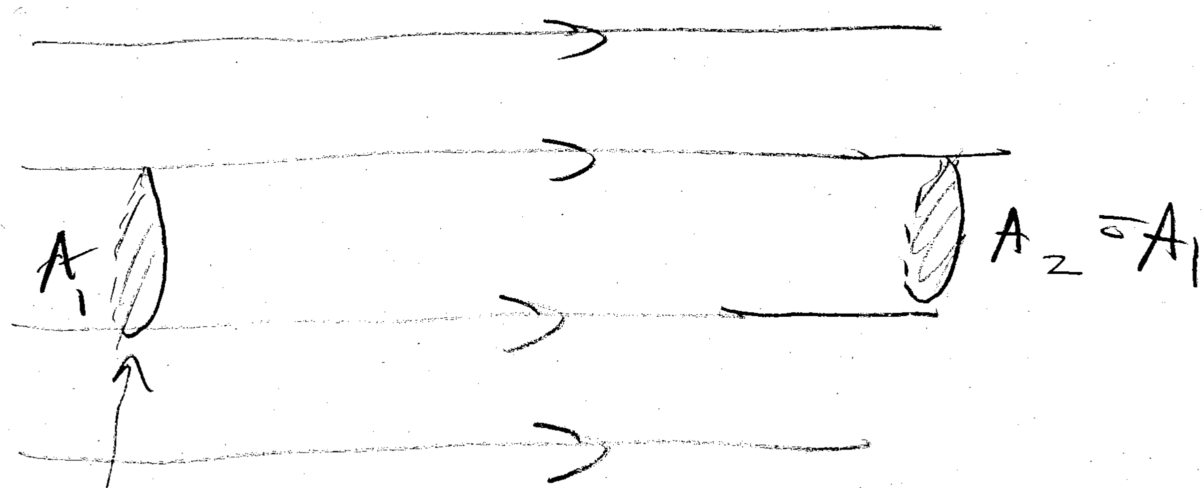
Add the two together
(in the rest frame of ball)




Roughening.. big effect!

# Fields of flow

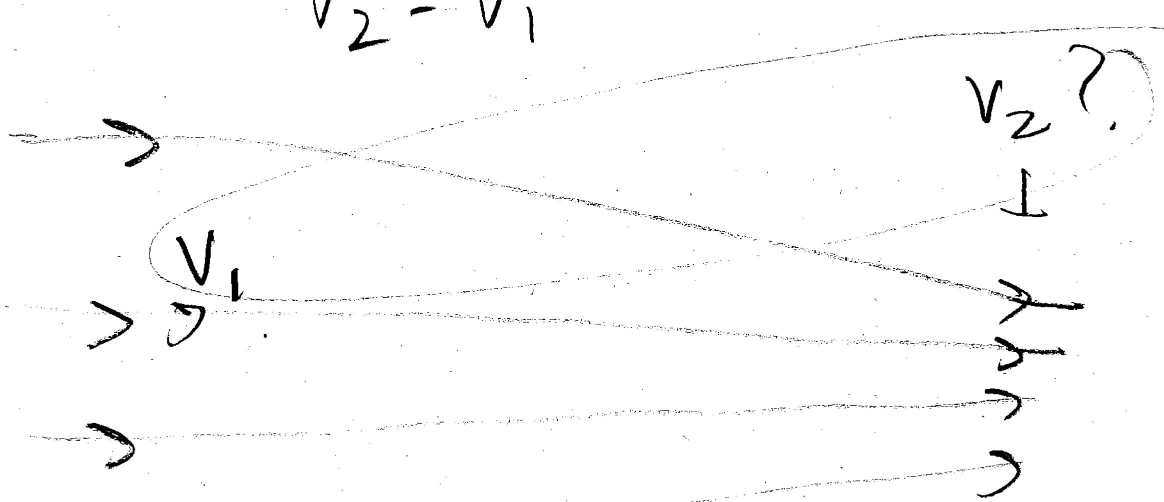
## Constant velocity




imagine TRANSVERSE AREA

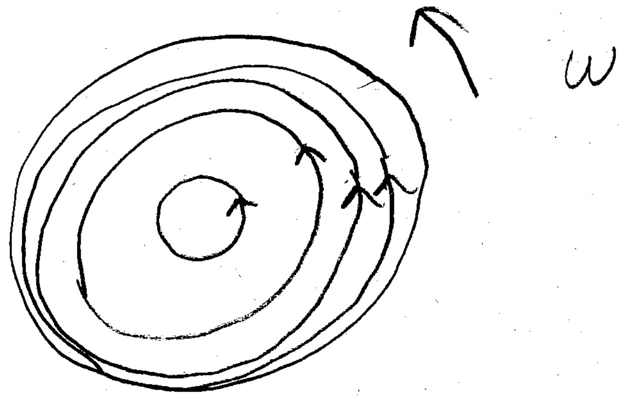
$$V_1 A_1 = V_2 A_2 \quad , \text{when } A_1 = A_2$$

$$V_2 = V_1$$




$$V_2 > V_1$$

Spin a cup - - - $\omega = \frac{V}{R}$ = constant




Down a drain - -

CENTRAL FORCE

$L$ = constant !

$L = mvr$, $v \propto \frac{1}{r}$