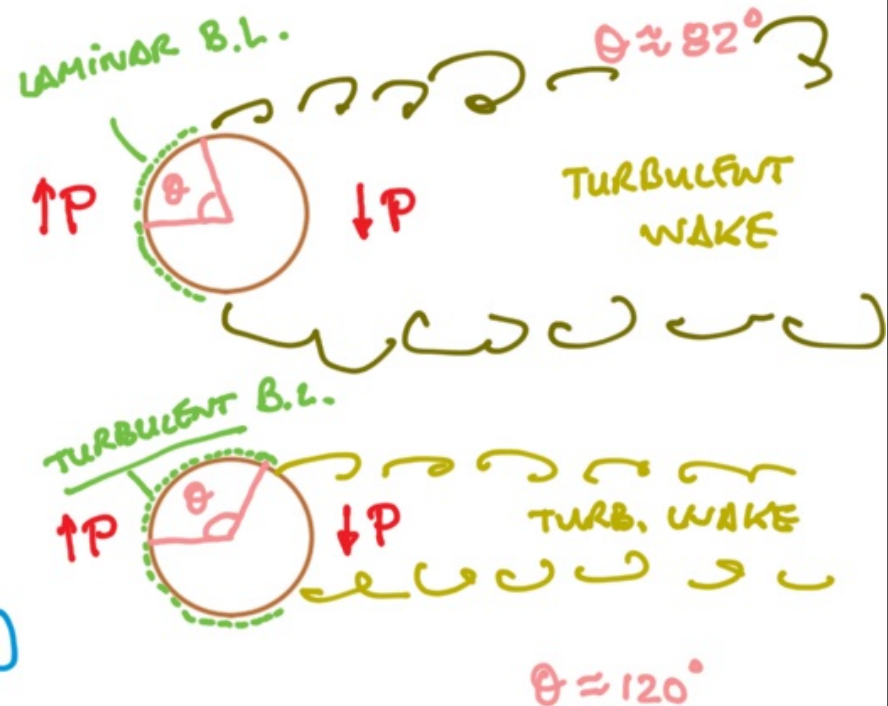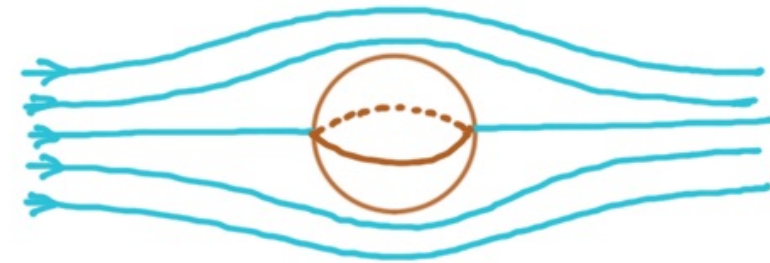- SMOOTH BALL (SPHERE)

- REGIME I: $0 < Re < 10^3$

 (LAMINAR EVERYWHERE)

 $C_D \downarrow$ with $Re \uparrow$

- REGIME II: $10^3 < Re < 10^5$

 $C_D \sim$ constant
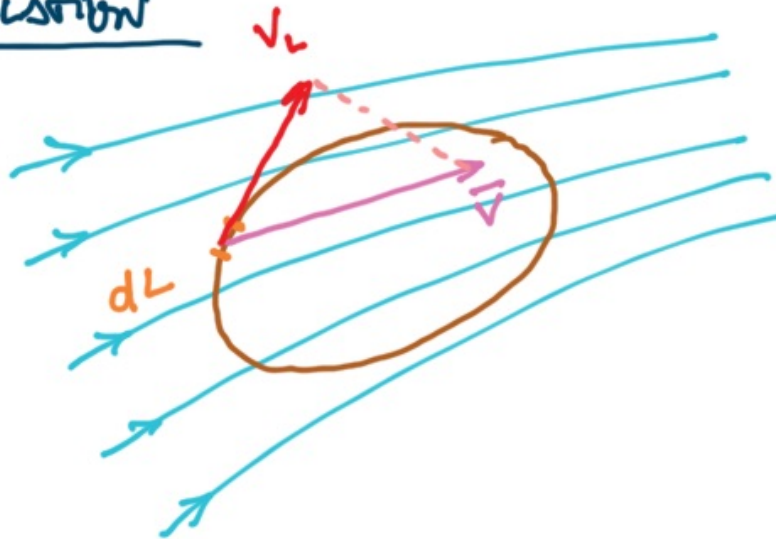
- REGIME III: $10^5 < Re < 5 \cdot 10^5$

 "CRITICAL" $Re \Rightarrow C_D \downarrow$

 ↳ (BL becomes turbulent)

LAMINAR B.L. $\quad \theta \approx 82°$

$\uparrow P \quad \theta \quad \downarrow P \quad$ TURBULENT WAKE

TURBULENT B.L.

$\uparrow P \quad \theta \quad \downarrow P \quad$ TURB. WAKE

$\theta \approx 120°$

	Golf ball	Helmet
v	$\approx 40\ m/s$	$\approx$
D	$\approx 0.05\ m$	$0.5\ m$
ν	$1.5 \times 10^{-5}\ \frac{m^2}{s}$	$=$
Re	$\sim 10^5$	$\sim 10^6$

- CIRCULATION

V_L

dL
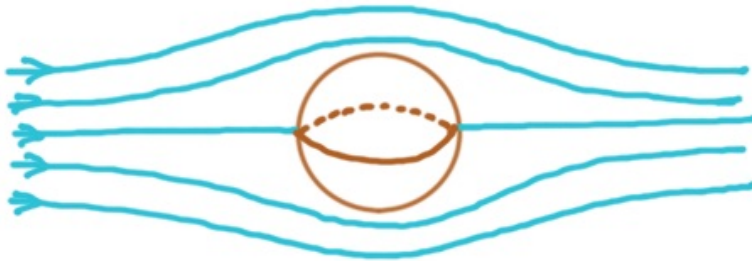
- Circulation:

$$\Gamma = \oint V_L \cdot dL$$

$$\Gamma = 0 \longleftrightarrow NO \ LIFT$$

- NO LIFT $(\Gamma = 0)$

- ROTATING BALL
$$\Gamma \neq 0$$

F_L

$\uparrow v, \downarrow P$

$\downarrow v, \uparrow P$

↑v, ↓P

↓v, ↑P

F_L

R

F_L

F_L