

Sphere

Drag coefficient $C_d = F_d / (1/2 \rho \pi R^2 U^2)$

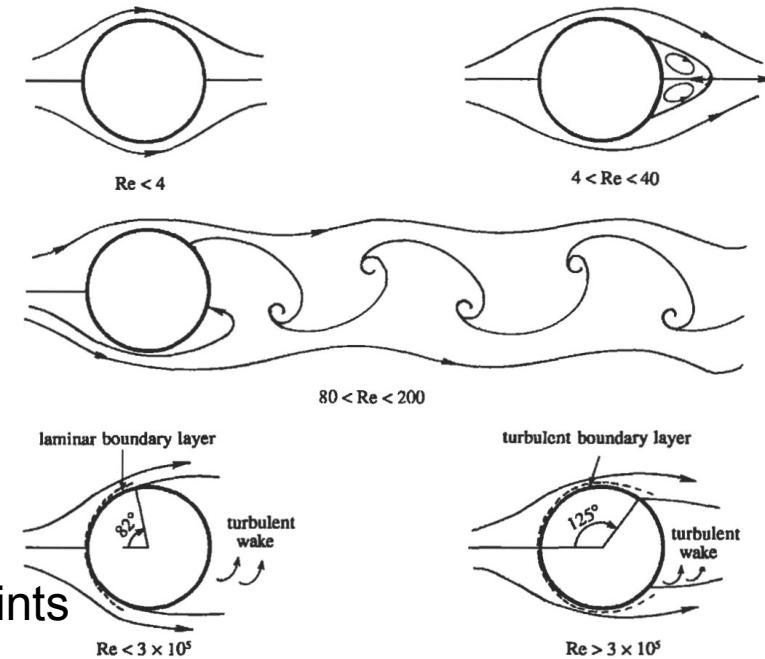
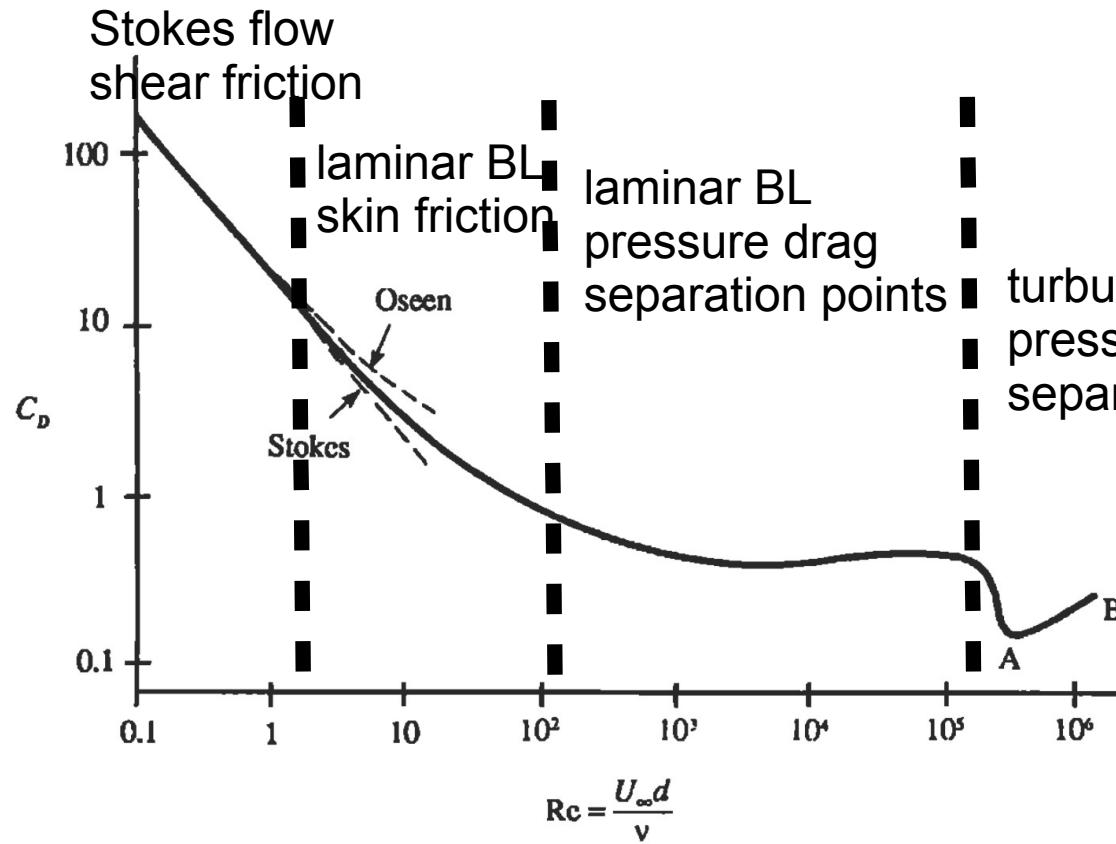
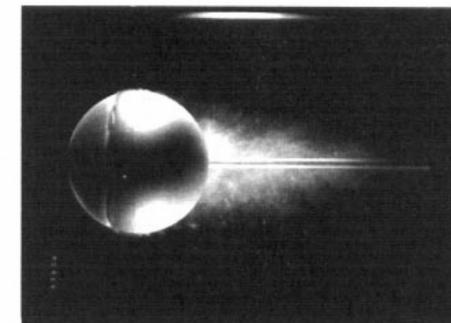
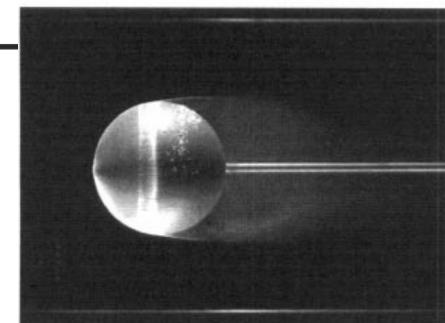
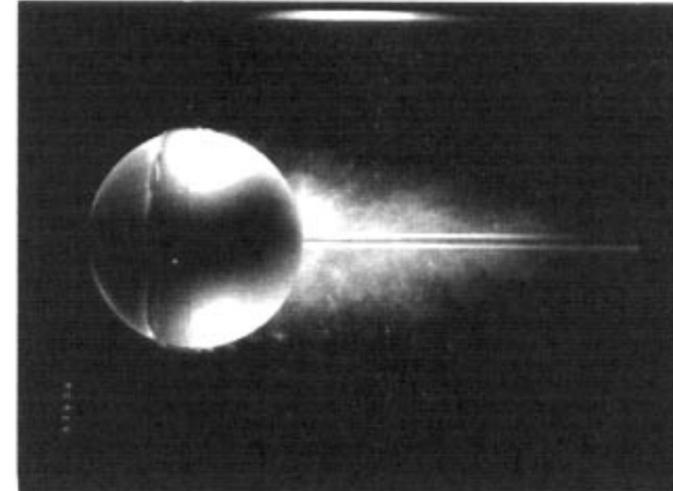
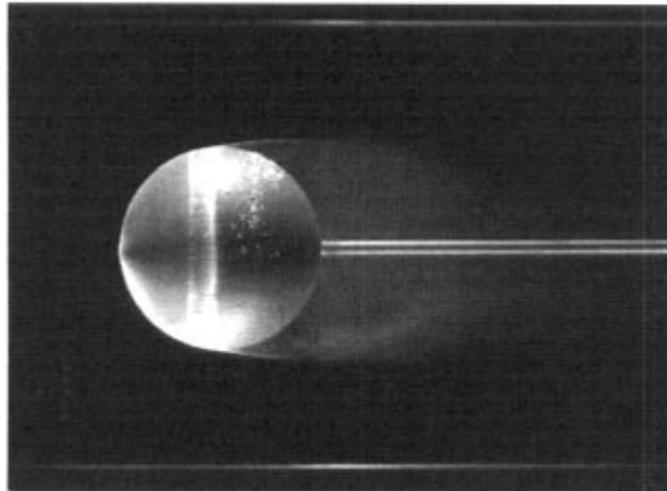


Figure 10.15 Some regimes of flow over a circular cylinder.

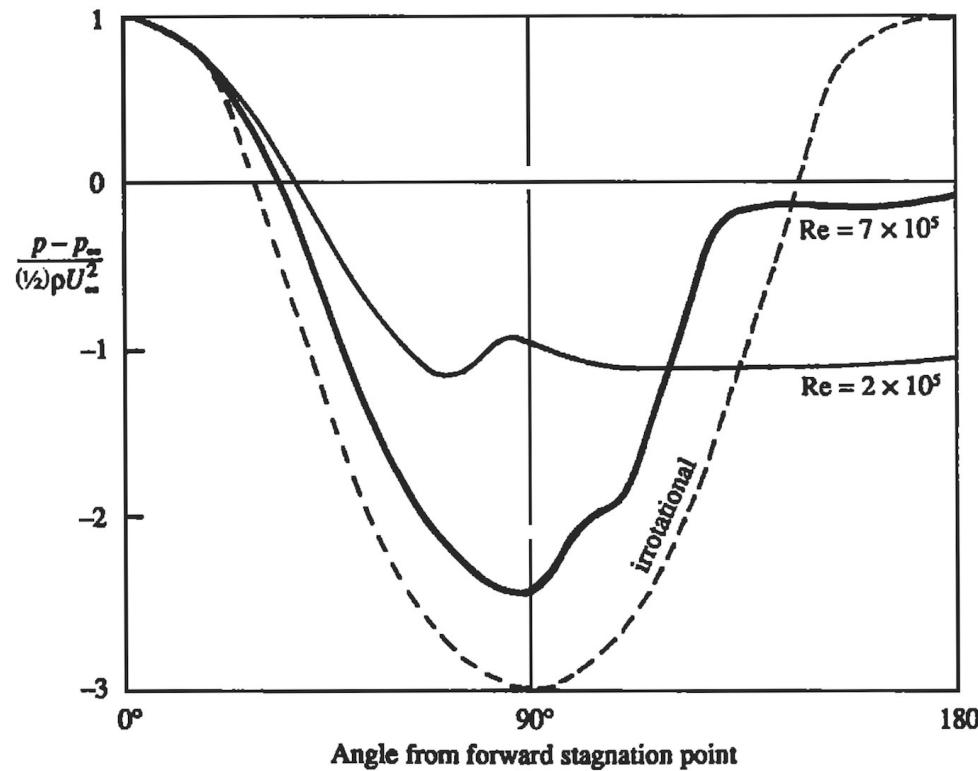


Sphere

$\text{Re} >> 10$: Drag = pressure force



$\text{Re} = 2 \times 10^5$



Geometry

$$Re \approx 10^4$$

Shape	Drag Coefficient
Sphere	0.47
Halfsphere	0.42
Cone	0.50
Cube	1.05
Angled Cube	0.80
Long Cylinder	0.82
Short Cylinder	1.15
Streamlined Body	0.04
Streamlined Halfbody	0.09

Measured Drag Coefficients

source wikipedia

airfoil

effect of the attack angle

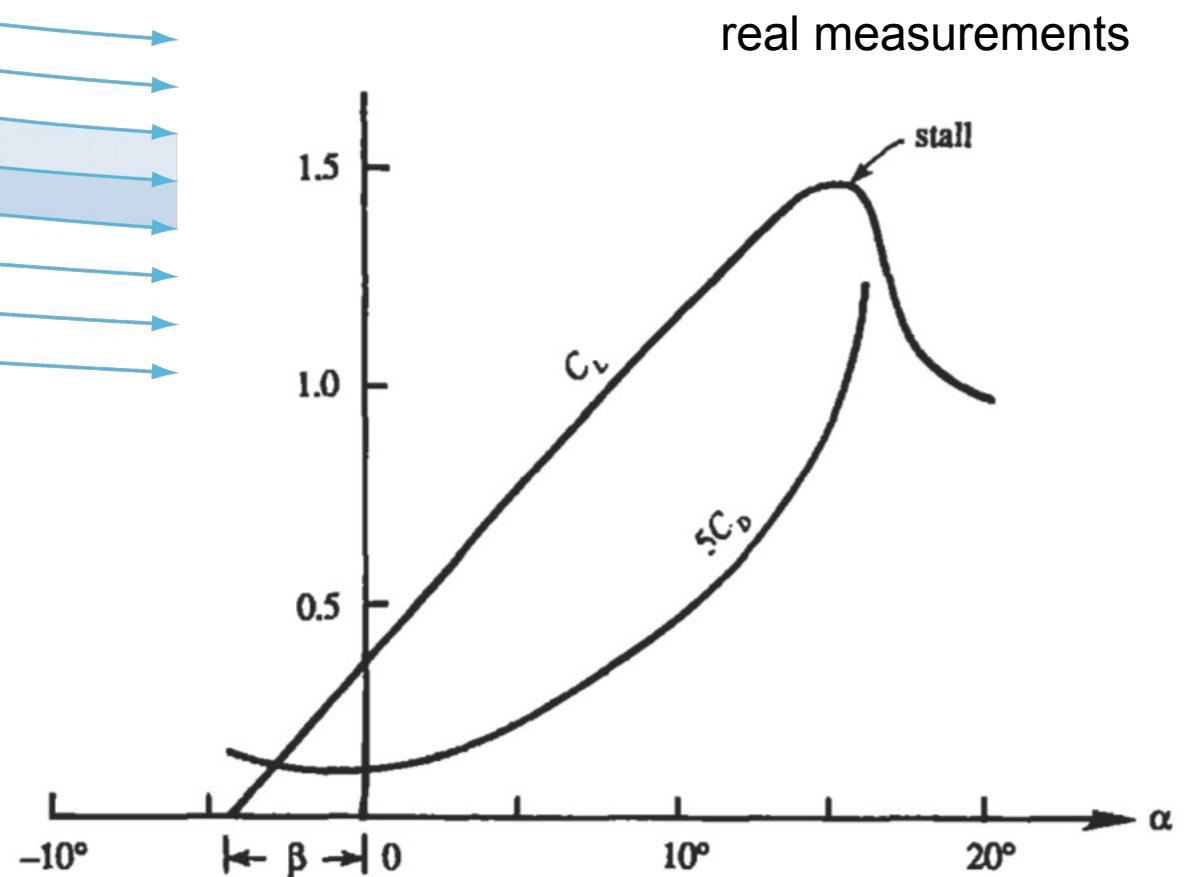
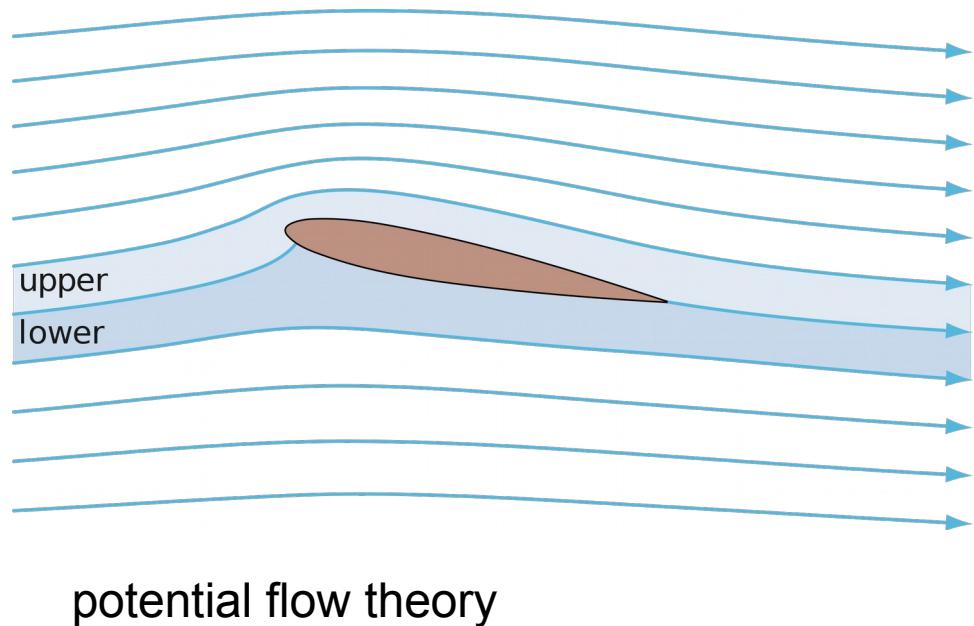


Figure 15.26 Lift and drag coefficients vs angle of attack.

Exercise

Roberto Carlos' wonder goal



$$\Omega_0 = 14 \text{ tours/s} = 88 \text{ rad/s}$$

$$U_0 = 40 \text{ m/s}$$

$$D = 21 \text{ cm}$$

$$M = 450 \text{ g}$$

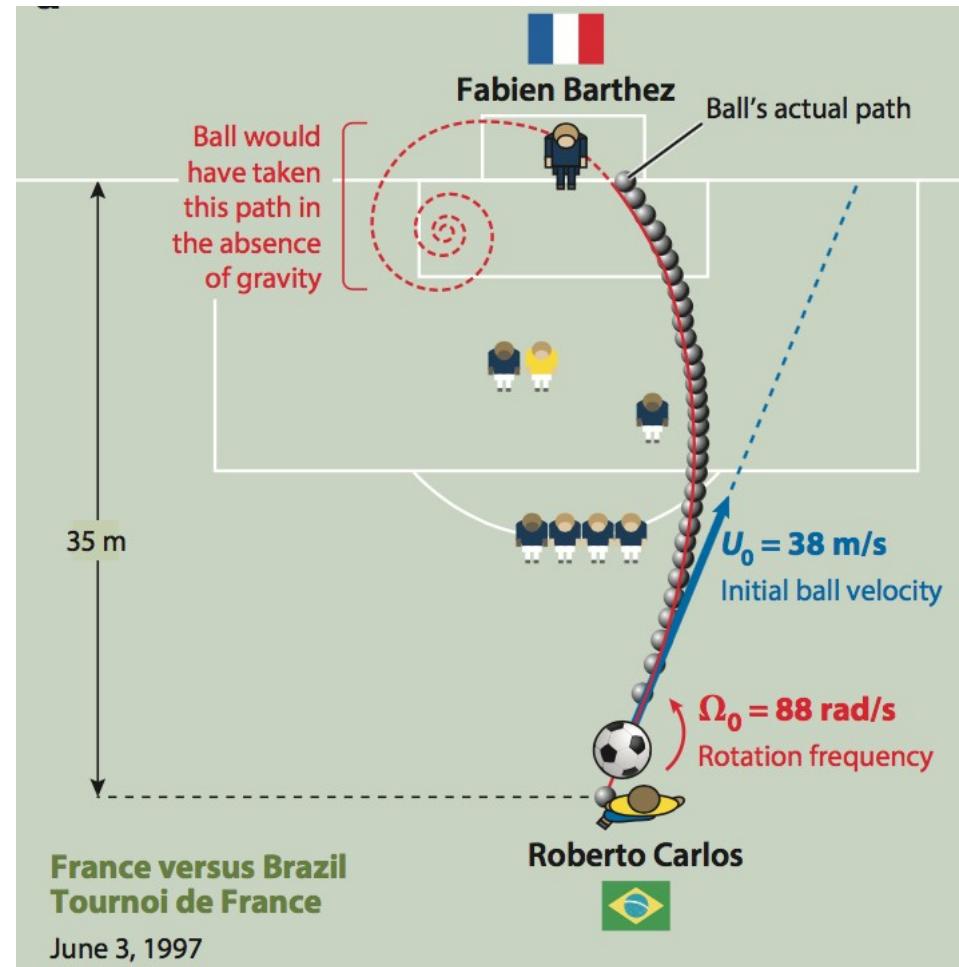
$$v_{\text{air}} = 1.5 * 10^{-5} \text{ m}^2/\text{s}$$

2D problem (gravity neglected)

Ω_0 constant

circulation $\Gamma \approx \Omega_0 R^2$

drag coefficient $C_D \approx 0.24$



WHAT IS THE
BALL TRAJECTORY ???