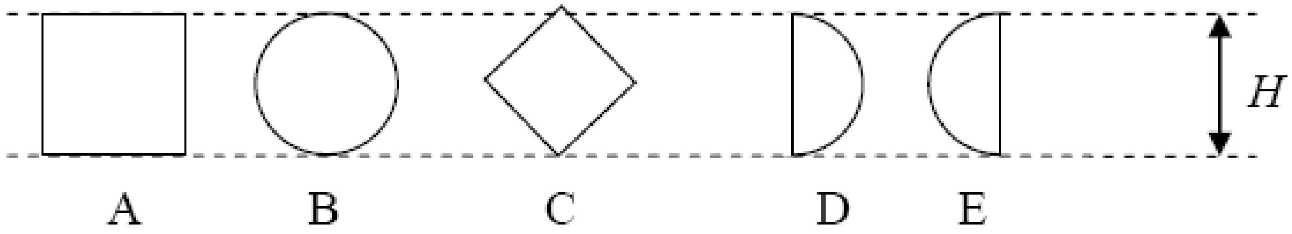
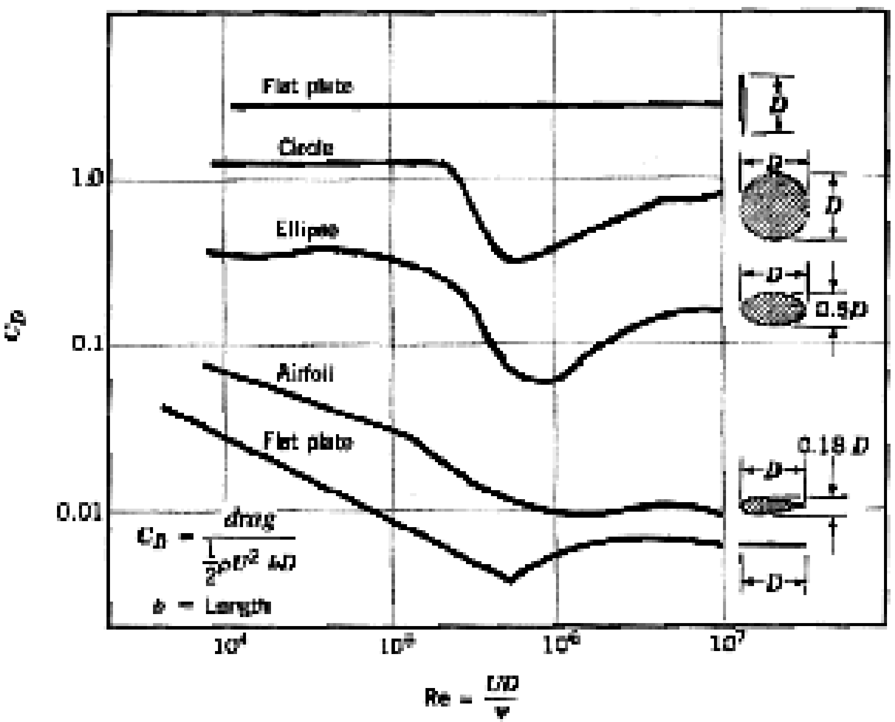
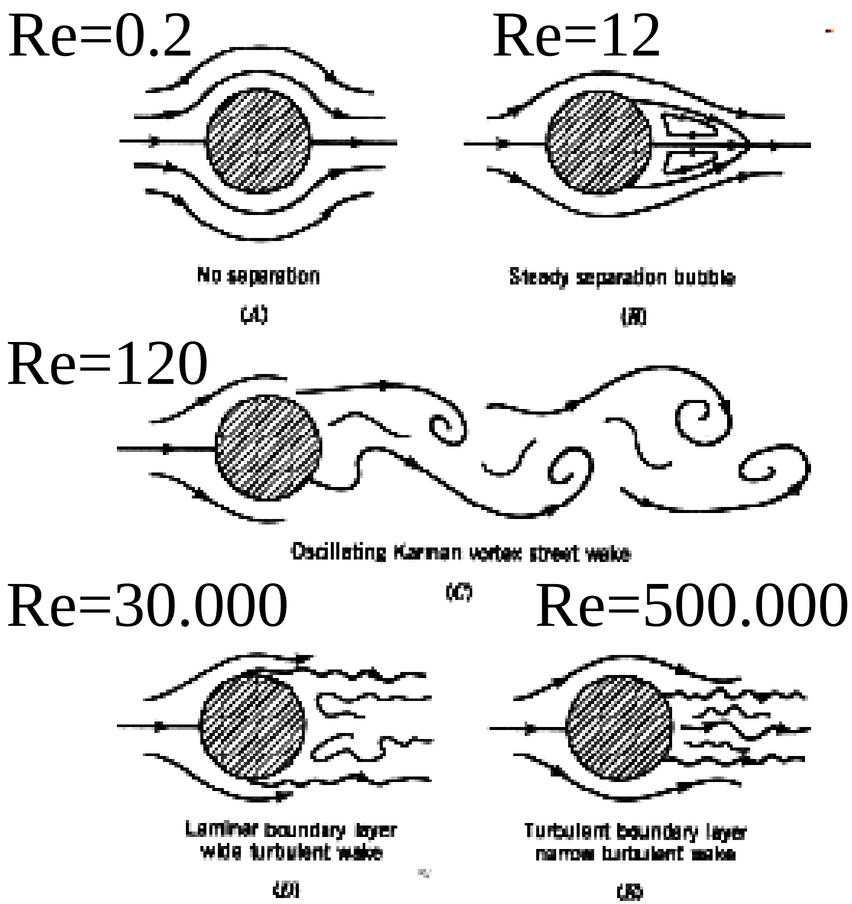
Individual task:

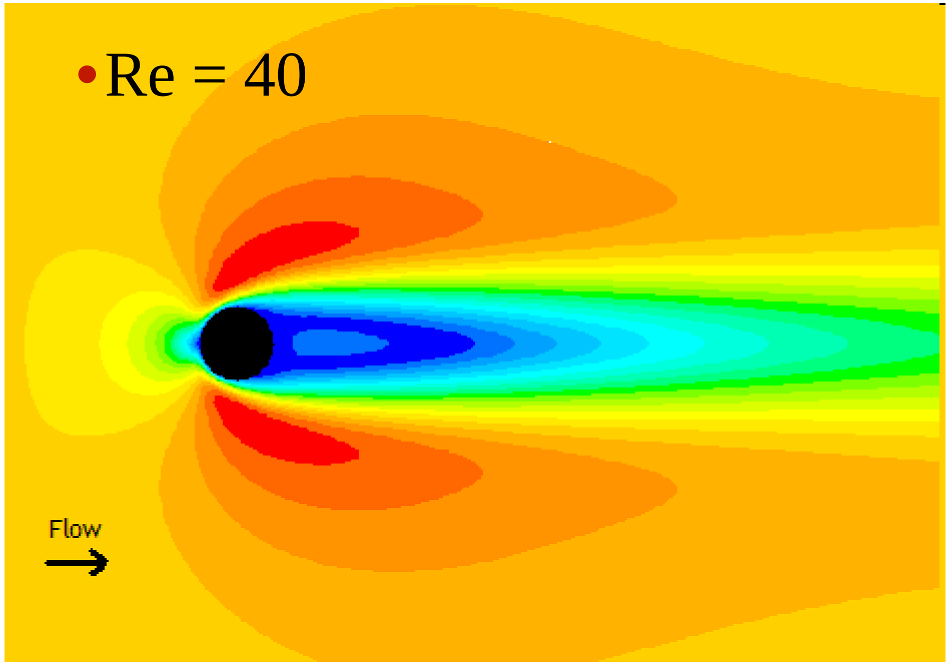
- Drag for a 2D object:



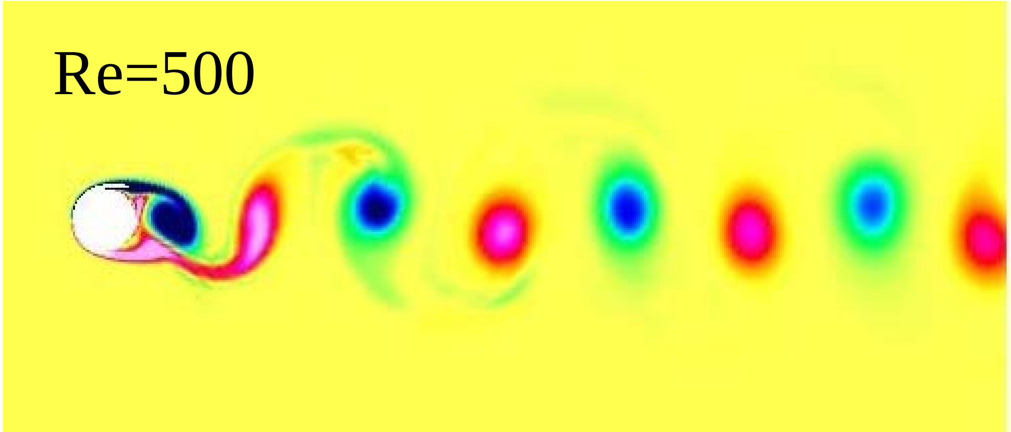
Reynolds no. dependency



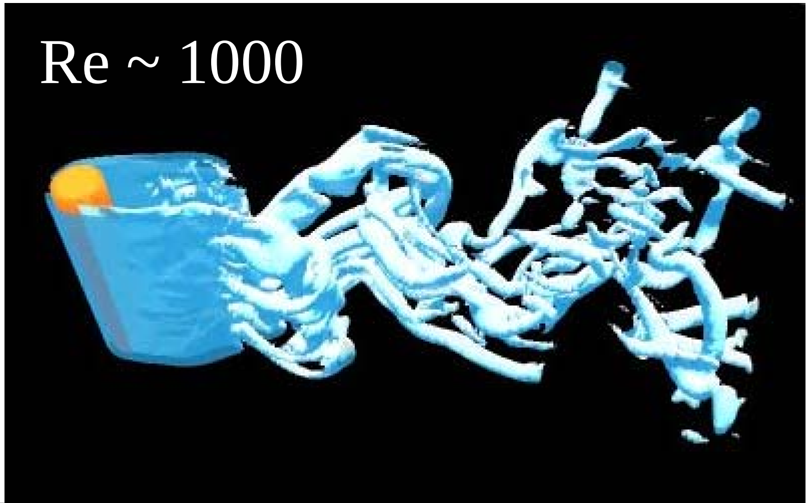




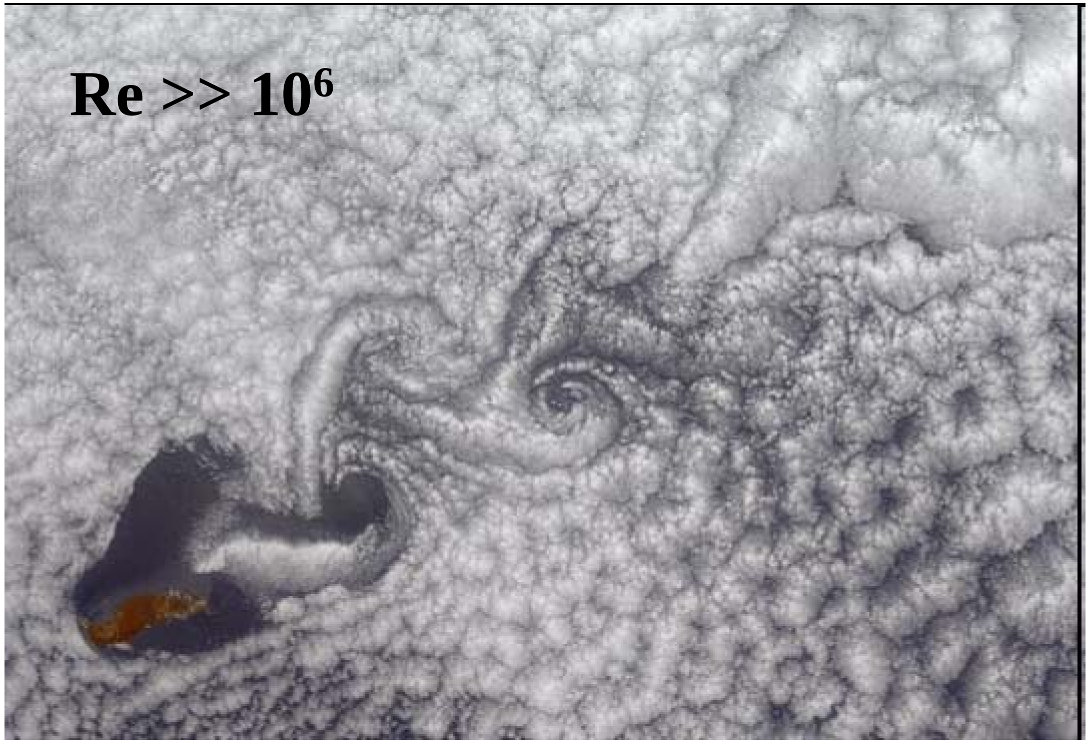
• Re = 40
Flow



Re=500



Re ~ 1000

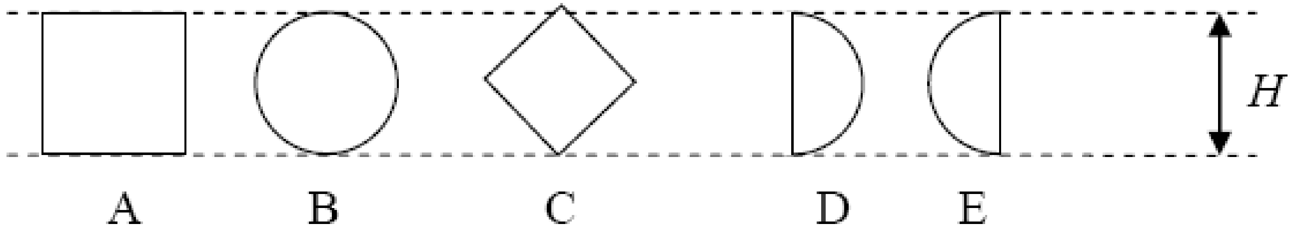


Re >> 10^6

What to do:

- Objective

  To derive the drag coefficient for a 2D object



- Setting
  - Choose object
  - Choose Re=10^4, 10^5 or 10^6
  - Incompressible: Ma<0.1
- Derive
  - Drag coefficient
  - Grid and flow pictures
- Different approximations – no ”correct answer”

When:

- Preparation for lecture 2 (23/3):

  Sketch, Physical model, Reynolds number

- During lecture 2 (23/3):

  Design the grid

- Before lecture 5 (16/4 12:00):

  Compute the case using Fluent

- During lecture 5 (17/4):

  Compare the numbers from the different cases

Group discussion – 15 min

Your individual task:

- Discuss your sketches
  - Expected flow field

- Design the grid
  - Boundary layer thickness, δ
  - Dy close to wall for
    - (i) log-law BC ($y^+ > 20$ AND $y < 0.1\delta$)
    - (ii) no-slip BC ($y^+ = 1$)
  - Use air, ν=1.8e-5m^2/s
  - Guess L and U – derive Re_L

... one solution

- Choose Re, e.g. $Re=10^5$
- Choose a cylinder, e.g. D=H=0.1m
  - $U = Re\,\nu / H = 18$ m/s
- Boundary layer will develop from stagnation point to max width.
  - That distance, x, is around 0.04m
  - $Re_x = 4 \times 10^4$
- Assuming turbulent boundary layer
  - The figure gives: Cf = 0.007 and $\delta/x = 0.04$
  - Cf definition -> $u_\tau = 1.1$ m/s
  - Boundary layer thickness $\delta = 0.04x = 1.6$ mm
  - y^+ definition -> $y=y^+\nu/ u_\tau$ gives:
    $y^+=1$ -> y=0.016mm and $y^+=20$ -> y=0.3mm
- OBS: Std. wall function BC cannot be used here. Why?
  - Thickness of the first cell: y_1
  - 1st req for WF: $y_1^+>20$ gives $y_1>0.3$mm
  - 2nd req for WF: $y_1<0.1\delta$ gives $y_1<0.16$mm