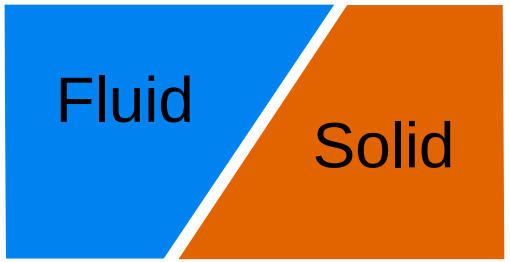
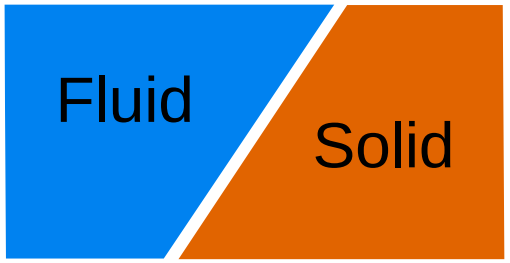
DIMENSIONLESS PARAMETERS



Coordinates	$\underline{x}$	$\underline{x}$	Coordinates
Time	t	t	Time
Velocity field	$\underline{U}$	$\underline{\xi}$	Displacement field
Viscosity	μ	E	Stiffness
Size	L	L	Size
Gravity	g	g	Gravity
Density	ρ	ρ_S	Density
Velocity Data	U_0	ξ_0	Displacement Data

FLUID AND SOLID



$$g(\underline{U};\underline{x},t;\mu,\rho,U_0;L,g;E,\rho_S,\xi_0)=0$$

N=11 parameters

FLUID AND SOLID

	$\underline{U}$	$\underline{x}$	t	μ	ρ	U_0	L	g	E	ρ_S	ξ_0
L	1	1	0	−1	−3	1	1	1	−1	−3	1
M	0	0	0	1	1	0	0	0	1	1	0
T	−1	0	1	−1	0	−1	0	−2	−2	0	0

Rank R=3

Number of dimensionless parameters P=11-3=8

A NEW DIMENSIONLESS QUANTITY

$$g(\underline{U};\underline{x},t;\mu,\rho,U_0;L,g;E,\rho_S,\xi_0)=0$$

$$G\left(\frac{\underline{U}}{U_0},\frac{\underline{x}}{L},\frac{U_0 t}{L},\frac{\rho U_0 L}{\mu},\frac{U_0}{\sqrt{gL}},\frac{\xi_0}{L},\frac{\rho_S gL}{E},A\right)=0$$

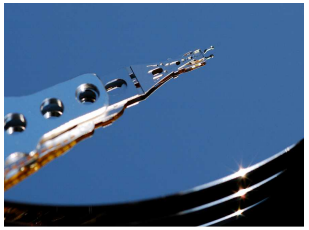
$$A=\frac{\text{Fluid}}{\text{Solid}}$$

THE MASS NUMBER

$$M = \frac{\rho}{\rho_S}$$

Mass number

Air



$M = O(10^{-4})$

Water

$M = O(1)$

THE REDUCED VELOCITY

$$U_R = \frac{U_0}{\sqrt{E/\rho_S}}$$

Reduced velocity

U_0

$$c = \sqrt{E/\rho_S}$$

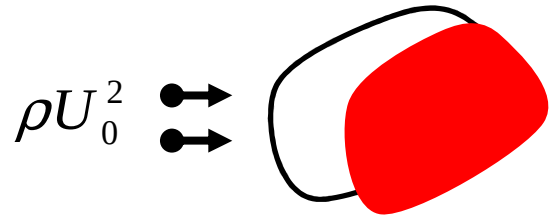
$U_R = O(10^{-3})$

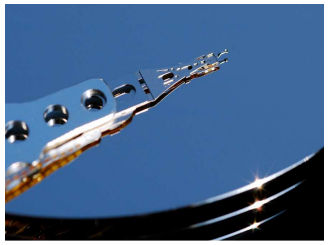
$U_R = O(1)$

THE CAUCHY NUMBER

$$C_Y = \frac{\rho U_0^2}{E}$$

Cauchy number





$C_Y = O(10^{-3})$

$C_Y = O(1)$

THE NEW DIMENSIONLESS NUMBERS

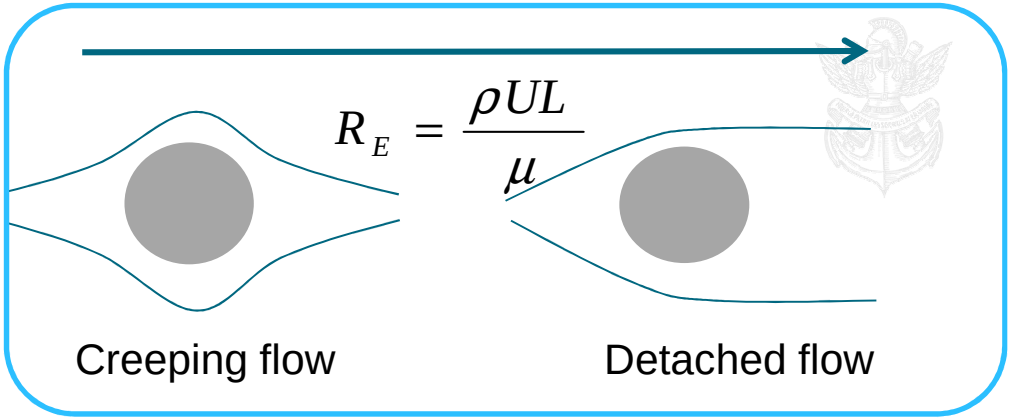
$$G\left(\frac{U}{U_0}, \frac{x}{L}, \frac{U_0 t}{L}, \frac{\rho U_0 L}{\mu}, \frac{U_0}{\sqrt{gL}}, \frac{\xi_0}{L}, \frac{\rho_S g L}{E}, A\right) = 0$$

$$M = \frac{\rho}{\rho_S}$$ Mass number

$$U_R = \frac{U_0}{\sqrt{E/\rho_S}}$$ Reduced velocity

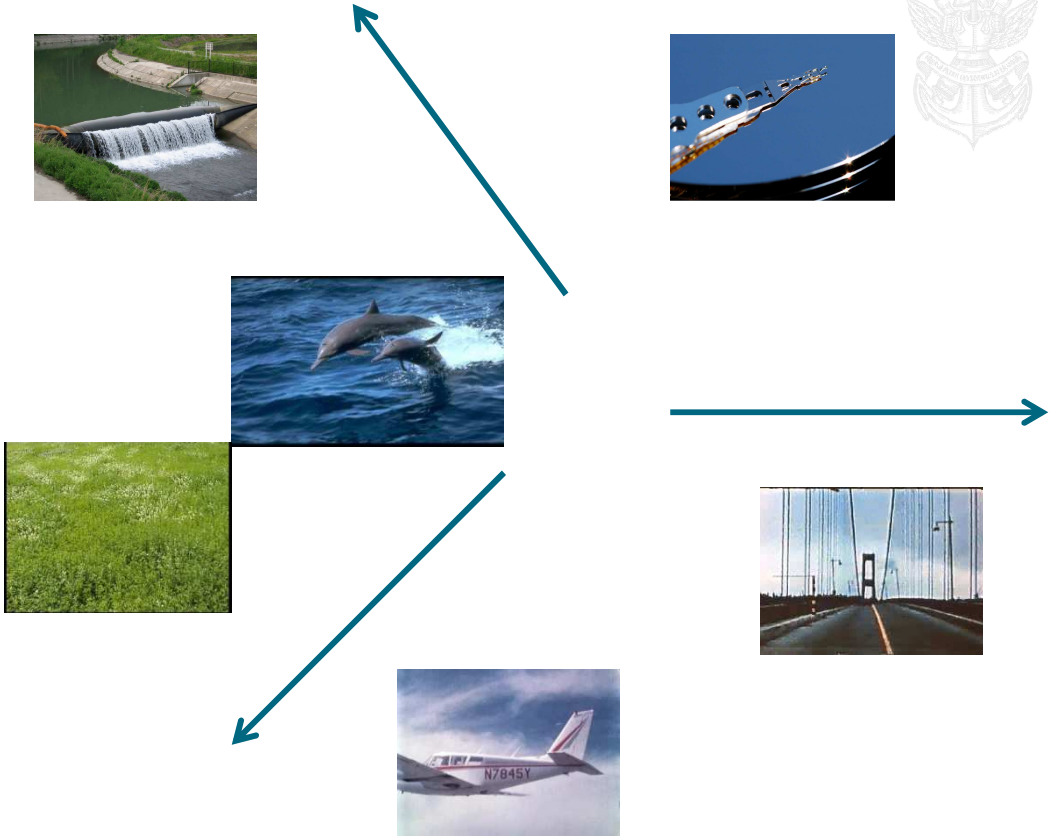
$$C_Y = \frac{\rho U_0^2}{E}$$ Cauchy number

CLASSIFYING PROBLEMS USING DIMENSIONLESS NUMBERS



$$M = \frac{\rho}{\rho_S}$$ Mass number

$$U_R = \frac{U_0}{\sqrt{E/\rho_S}}$$ Reduced velocity

$$C_Y = \frac{\rho U_0^2}{E}$$ Cauchy number

CLASSIFYING PROBLEMS USING DIMENSIONLESS NUMBERS