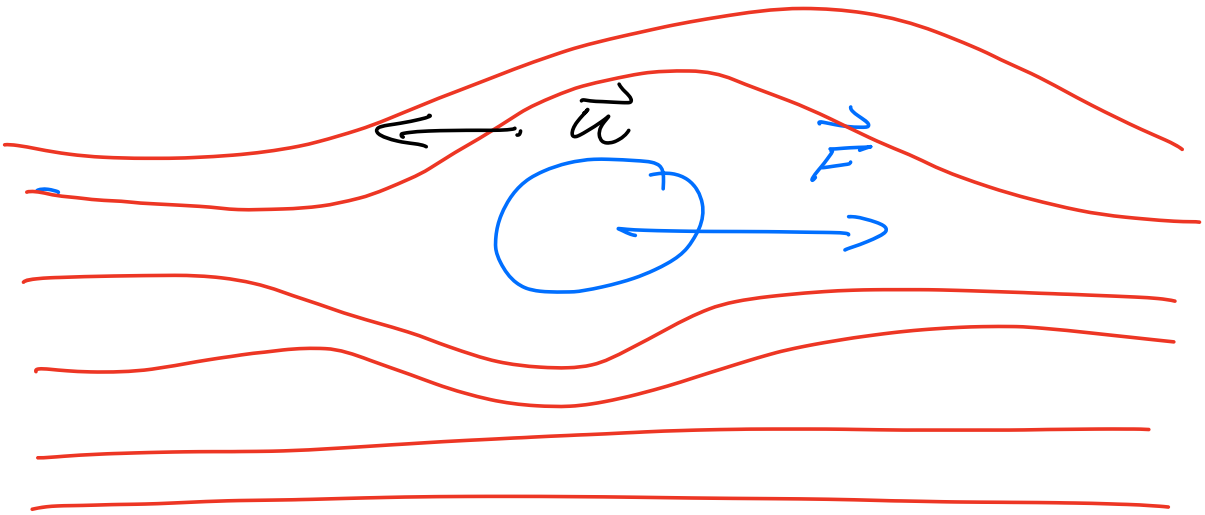
Force Model - Viscous Drag

- object in contact with environment, here a fluid, air etc



At low velocity the fluid flows smoothly around the object.

Experiment and theoretical models indicate that

$$\vec{F}_D = -k_v \vec{v}$$

Stokes constant

$$K_V = 6\pi\eta R$$

R = Radius of sphere

η = viscosity of fluid.

Air at room temperature

$$\eta = 1.82 \cdot 10^{-5}\ Ns/m^{-2}$$

water

$$\eta = 1.00 \cdot 10^{-3}\ Ns/m^{-2}$$

$$\vec{F}_D = -D\vec{v}|\vec{v}|$$

one-Dim

$$F_D = -Dv^2$$

Object which sweeps a volume ΔV in time Δt

A = cross sectional area which it sweeps through at a velocity $\vec{v}$

a body with velocity v

$$\Delta V = A \cdot \underbrace{v \cdot \Delta t}_{\text{distance}}$$

$$\frac{\Delta V}{\Delta t} = A \cdot v$$

mass density

$$\rho_m = m / \Delta V$$

$$\Delta p = m \cdot v = \rho_m \Delta V v$$

$$= \rho_m \Delta t A v^2$$

$$\frac{\Delta p}{\Delta t} = \rho_m A v^2$$

time $\Delta t \to 0$ $\quad \frac{\Delta p}{\Delta t} = F = \underbrace{\rho_m A}_{D} v^2$

$$\vec{F}_D = -D \vec{v} |\vec{v}|$$

+ friction force ($\vec{v}$)

In gravitational field (II)

$$F_{net} = \vec{G} + \vec{F}_D$$

$$= -mg + Dv^2$$

$$a = -g + \frac{D}{m} v^2$$

$$a = \frac{dv}{dt} \quad \wedge \quad v = \frac{dy}{dt}$$

$$-g + \frac{D}{m} v^2 = \frac{dv}{dt}$$

$$dt = \frac{dv}{-g + \frac{D}{m} v^2}$$

$$\int_{t_0}^{t_m} dt = \int_{v_0}^{v_m} \frac{dv}{-g + \frac{D}{m} v^2}$$