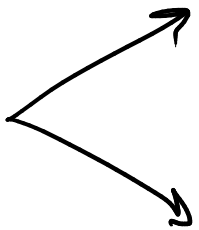
Friction

Dry (Coulomb) friction



stick $\quad v_{ct} = 0$

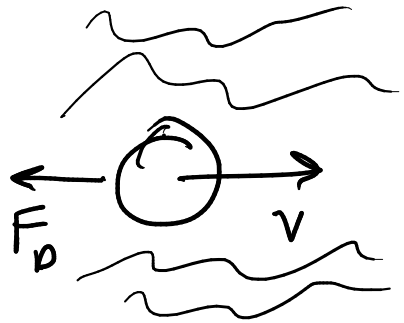
$|F| \leq \mu |N|$

slip $\quad v_{ct} > 0$

$|F| = \mu |N|$

Viscous friction (wet friction)

drag model:

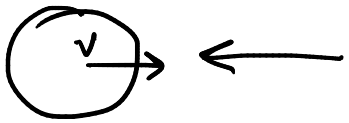


$$F_D = \frac{1}{2} \rho v^2 C_D A$$

- ρ: density of fluid
- v: relative velocity to fluid
- C_D: coeff of drag, $C_D \sim 1$ bluff
- A: cross-sectional area

why V^2

$$F_{air} = \dot{p}_{air} = \frac{\Delta p}{\Delta t} = \frac{m \Delta v}{\Delta t}$$

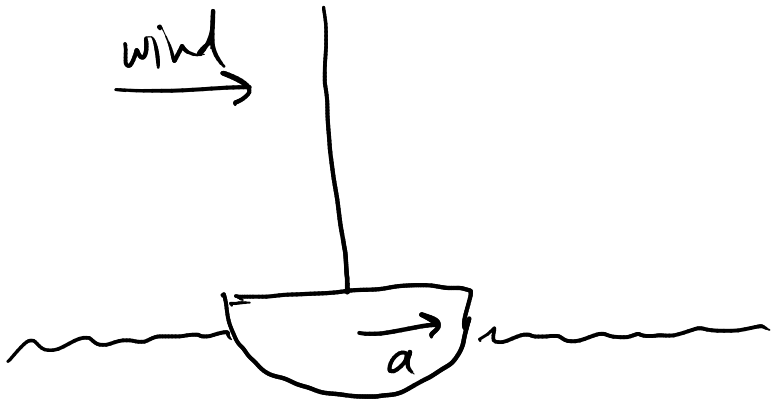


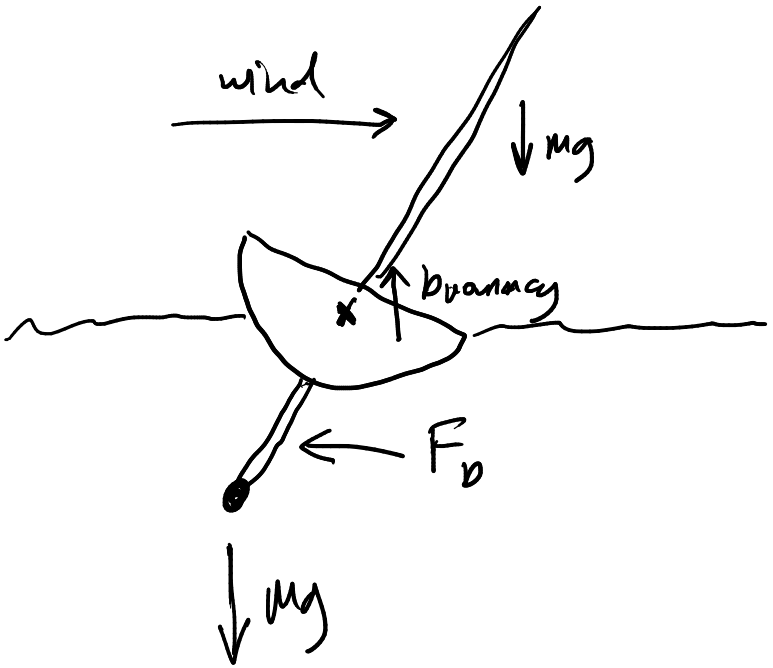
double speed of object

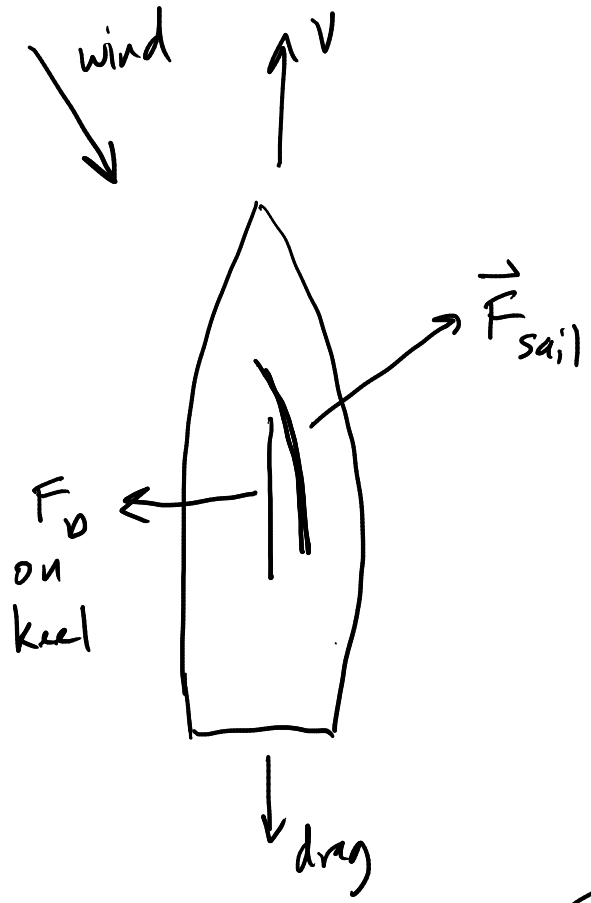
$\Rightarrow$ doubles the velocity change

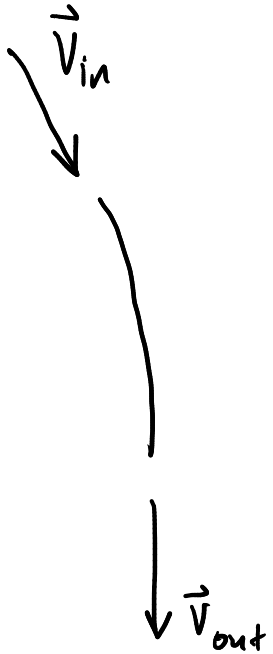
$\Rightarrow$ doing this to twice as much fluid mass

$\rightarrow$ 4x the momentum change.



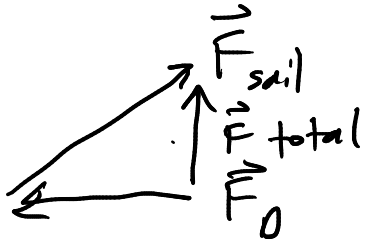






Change dir of air

$\Delta\vec{V} = \vec{V}_{out} - \vec{V}_{in}$



$$\vec{F} = \frac{\Delta \vec{p}}{\Delta t}$$