Dimensions & Units

$\vec{F} = \frac{m\vec{a}}{g_c}$		Dimensions				
		Mass [m]	Length [L]	Time [t]	Force [F]	Temperature [T]
Units	English	slug lb_m	Ft	s	lb_f	R
	SI	Kg	m	S	N	K

g_c is a dimensional constant of proportionality
SI (MLtT) → $g_c = 1$

English System:

- F: lb_f, m: lb_m, a: Ft/s^2 → $g_c = 32.2\ lb_m Ft/lb_f s^2$
- F: lb_f, m: slug, a: Ft/s^2 → $g_c = 1\ lb_m Ft/lb_f s^2$

For English Calculations case (2) is easier to use & 1 slug = 32.2 lb_m

Dimensions & Units

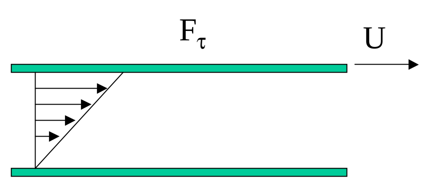
Pressure: Compressive normal stress

- SI: [P] → N/m^2
- English: [P] → lb_f/Ft^2

Viscosity: Internal resistance to deformation
Recall our simple 1D description of Shear Stress:

$$\tau \propto \frac{\partial u}{\partial y} \qquad \tau = \mu \frac{\partial u}{\partial y} \qquad \nu = \frac{\mu}{\rho}$$

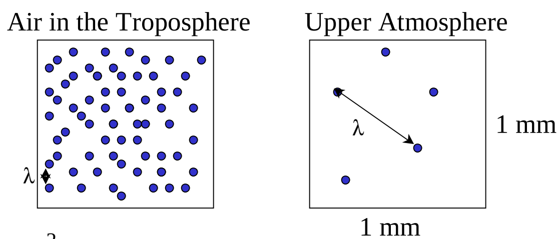
1. Dynamic viscosity, μ
   - SI: [μ] → $N\text{-}s/m^2$
   - English: [μ] → $lb_f\text{-}s/Ft^2$
2. Kinematic viscosity, ν
   - SI: [ν] → m^2/s
   - English: [ν] → Ft^2/s



Continuum Hypothesis – Classical Fluid Mechanics

- Since most fluids systems are composed of billions of molecules: *Every property is assumed to be well described as continuous functions of space* (I.e., every property has a value at every point in space)
- There are enough molecules in a given volume such that the properties are continuous functions
- Validity:

λ – Mean Free Path of molecules – average molecule spacing (at STP ~ 6.4 x 10^{-5} mm)



If $l/\lambda \geq 10^2$ then we usually assume the continuum assumption is valid (here l is some characteristic length scale, width of space craft)