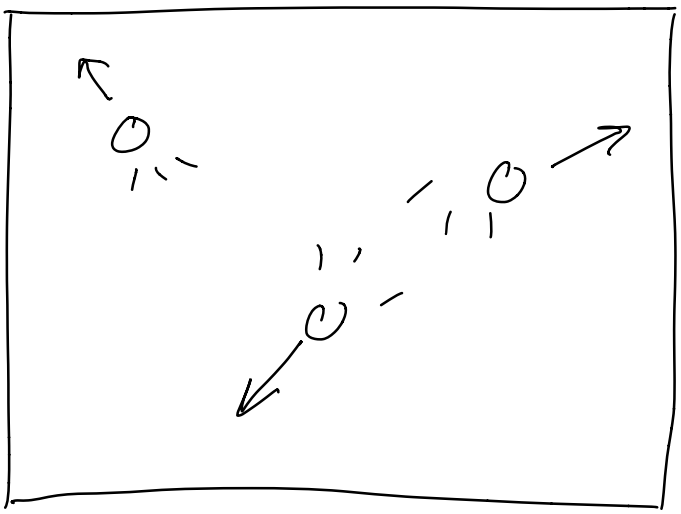
Think about the air in this room

What is air?

A bunch of atoms, mostly nitrogen & oxygen, moving around randomly

At room temp, $v \sim 500$ m/s (1100 mph)

Not like solids



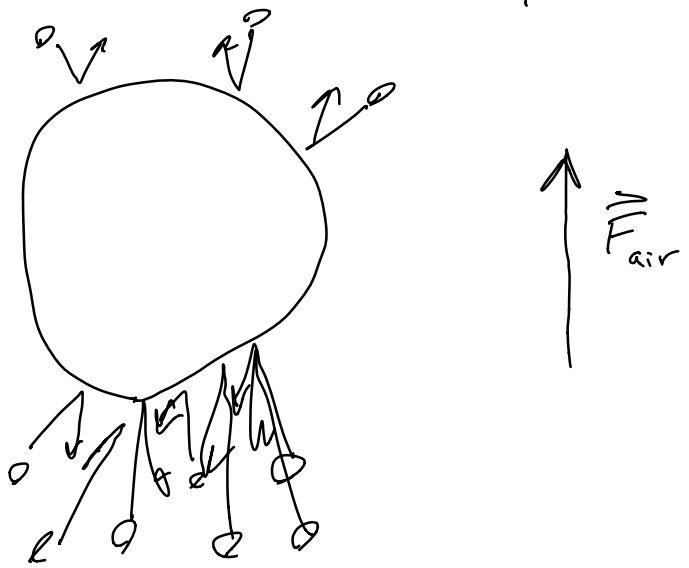
On average, $\vec{v} = 0$ (no preferred direction)

- Air molecules are constantly bombarding you from every direction

- Each time they collide, they exert a force on you (very small, since mass of a molecule is very small (2×10^{-23} g))

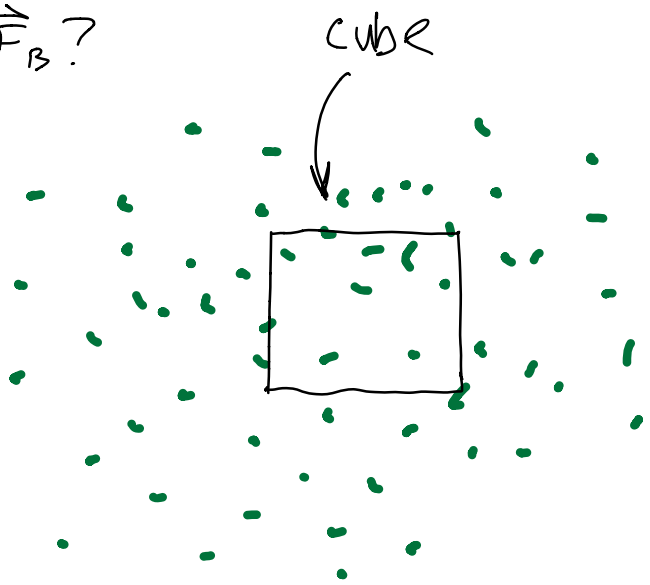
- But air gets less dense w/ altitude (due to gravity)

- more collisions on bottom than top



This is the buoyant force $\vec{F}_B$

What is $\vec{F}_B$?



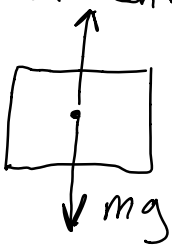
molecules are always entering & exiting the box, but on average, the air density in the box is the same as everywhere around it
- the box is not moving ($p = 0$)

If it were moving, we would feel a rush of air

This means that $\vec{F}_{net} = 0$ on the box

What are the forces?

The box contains air, which has mass

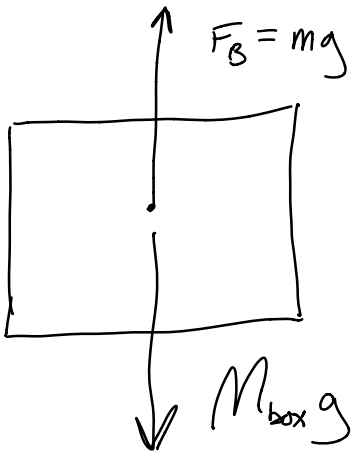


m is the total mass of air in the box

$$F_B - mg = 0 \Rightarrow F_B = mg$$

- Now, remove the box of air & replace it with an actual box filled with something (mass $= M_{box}$)

Sum forces:



$$|\vec{F}_{net}| = mg - M_{box}g$$

Upward force equal to the weight of the air displaced by the object

if box has a volume V, the

$$m = (\text{air density}\left[\frac{kg}{m^3}\right] \times V\,[m^3]$$

$$m = \rho_{air} V$$

$$F_B = \rho_{air} V g$$

$$F_{net} = \rho_{air} V g - M g$$

$$F_{net} = (\rho_{air} - \rho_{box}) V g$$

$$F_{net} = (\rho_{air} - \rho_{obj}) V_{obj} g$$

Object is:

- less dense than air?
  float upward
- as dense as air?
  not move
- denser than air?
  sink

Same principle applies to water:

$$F_B = \rho_{water} V_{obj} g$$

$$F_{net} = (\rho_{water} - \rho_{obj}) V_{obj} g$$

This is why an 800 million lb aircraft carrier floats

Why you sink in water when you exhale all air