1. **The Viscosity of Air**

Viscosity in a fluid arises because the microscopic motions and collisions of molecules between neighbouring fluid elements causes these elements to exchange momentum. Let’s try and get an order of magnitude estimate of the kinematic viscosity of air from the physics of these microscopic collisions.

Recall that the kinematic viscosity has units of $m^2s^{-1}$, i.e. a speed times a length. You therefore might suspect that the kinematic viscosity is simply a characteristic random velocity of the molecules times a characteristic length scale concerning collisions. Using the rms thermal speed ($3kT/m^{1/2}$) as the characteristic random velocity, and the mean free path as the characteristic length, estimate the kinematic viscosity of air, at a given temperature and density. From this, calculate the dynamic viscosity - you should find that the density dependence drops out, and that your answer is pretty accurate! How about the temperature dependence of your result - does this agree with experiment?

2. **Wind Dispersal of Plant Spores**

Consider a spore of a plant that has a radius of $15 \mu m$, sitting on a leaf. It turns out that such spores need an air velocity of roughly $2 \text{ cm/s}$ at the spore centers to get enough drag for them to leave the leaf and join the air stream. If such a spore is $4 \text{ cm}$ away from the upwind edge of the leaf surface, how fast must the wind be blowing well away from the leaf to take the spore with it?

3. **Why is there no plankton in air?**

The ocean is teeming with small suspended organisms, while air is relatively devoid of life. This is partly due to the difference in drift velocity. Using Stokes drag, compute the downward drift speed for a falling particle of radius $a = 10 \mu m$ and density $\rho \sim 1 \text{ g cm}^{-3}$ in (a) air, and (b) water. (c) What other factors might influence how well a particle can stay suspended in air vs. water.

4. **Laminar boundary layer for a sound wave.**

Consider a sound wave hitting a wall. The component of velocity parallel to the wall is $U(t) = \omega \xi \cos(\omega t)$ far from the wall, where $\xi$ is the amount of displacement for the fluid element.

(a) What is the size of the boundary layer for a sound wave with frequency C sharp?

(b) The Reynolds number of the flow depends on how loud the sound is.
At what fluid displacement is the Reynolds number unity?