ME 55600
Homework #4: Low Re Flow

In low Reynolds number flow the drag force on a spherical particle is given by the formula:

$$F_D = 6\pi\mu UR$$

where μ is the fluid viscosity, U is the particle velocity, and R its radius.

Consider dust particles in the atmosphere. They can be created by volcanoes, pollution and storms, and can be of various sizes. Ignoring other atmospheric effects, and assuming that the particles are spherical and that their relative speed is small, their motion can satisfy the low Re number approximation $Re \ll 1$.

In a quiescent atmosphere the particles will descend at a constant speed U. Write the force balance equation for a spherical particle taking into account its weight, buoyancy and drag forces, and obtain the result for the particle velocity.

Use an order of magnitude estimates for the particle and air properties and determine the terminal velocity for a $0.1\ mm$ and $0.01\ mm$ particles. Check if the low Re assumption is valid.

Estimate how long it will take for either particle to descent $1\ km$, and how long can small particles remain in the atmosphere if their initial altitude is $10\ km$.