Particle dynamics class, SMS 618, Emmanuel Boss
(Last modified 10/12/2009)

Settling lab (based on Ch. 3 of J. R. L. Allen's: Principle of Physical Sedimentology, 2001, Blackburn press):

Material:

Plastic, glass and metal beads of different sizes.
Sieved sand from 1→4ϕ size range.
Stop watches.
Caliper, scale.
Shell pieces.
Aluminum foil pieces
2 2l' Cylinders one with H_2O the other with Glycerine.

Methods:

1. Release the beads with forceps one by one and measure the settling velocity in both fluids starting the measurement from 10cm below the release point to 10cm above the bottom. These experiments will be used to provide you an estimate of the viscosity and density of the fluid, so use the ones that take the longer to sink (and hence have the least uncertainties). For particles with low Reynolds number Stokes settling is:

$$w_s = \frac{2(\rho_p - \rho_f)gR_p^2}{9\mu_f} ms^{-1}$$

Where μ_f is the fluid viscosity while ρ_f is its density. ρ_p is the particle's density while R_p its radius. You also have a caliper and a scale to obtain the particles' properties.

Were the Reynolds number is: $\mathrm{Re} \equiv \frac{\rho_f R_p w_s}{\mu_f} = \frac{R_p w_s}{\nu_f}$.

Now that you know the density and viscosity of the fluid you are in a position to test whether Stokes formula is applicable to real sieved particles.

2. Measure the settling speeds of at least three natural particles of each different size.

3. Measure the settling velocities of shells released in different orientations in the fluid.
4. Observe the settling velocity of disks made out of aluminum foil in <u>air</u>, water and Glycerine.

Assignment:

1. Use the different glass beads settling in Glycerine to back out the density and viscosity of Glycerine assuming Stokes settling. How do they compared to published values (which can be found on the WWW)

2. Plot the settling velocity of sand grains as function of size. Is it consistent with Stokes's settling? What are the Reynolds' numbers of the particles? Can differences be explained based on the non-sphericity of the particles (take into account likely uncertainties)?

3. How does shape affect settling of shells. Is there a preferred orientation in some fluids (compute the Reynolds number and see if some rules come out)? Do they stay at the orientation they started with?

ϕ	Diameter [μm]	Sample #	size	w_s-water	w_s-glycering
4	62.5	1	62.5-88.4		
3.5	88.4	2	88.4-125		
3	125	3	125-177		
2.5	177	4	177-250		
2	250	5	250-354		
1.5	354	6	354-500		
1	500	7	500-707		
0.5	707				

composition	Size	fluid	Settling velocity	notes

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