SMS-204: Integrative marine sciences.

Homework 5, Reynolds #, flows and swimming.

1. (60/100) The table below contains data similar to those found in Lab 1.
   Fill out the table by doing the following:
   Be careful to convert to consistent units!

Bead Diameter (mm)	Sinking Velocity (cm/s)	Velocity x Diameter	Reynolds Number (unitless)	Drag Force (newtons)
3.17	2.45			
4.76	5.52			
6.35	9.81			
9.52	22.09			
12.7	39.27			

   a. Compute the Reynolds number (*Re*) for all different settling spheres (assume that for glycerin μ=1.4Kg/s/m (Pa s) and ρ~1.26g/ml .

   b. Determine the drag force on sinking spheres, assuming that when the spheres reach constant settling speed and no net force is acting on the bead:

   $$F_{drag}=F_{gravity}-F_{buoyancy}=gV_{sphere}(\rho_{sphere}-\rho_{glycerin})$$

   Where g is the gravitational acceleration, V_{sphere} the sphere volume and ρ the density of the metal spheres, ρ_{sphere}=7800Kg/m^3, and glycerin $\rho_{glycerin}$=1260Kg/m^3.

   c. Plot F_{drag} (based on the equation above) as function of velocity x diameter

   d. Obtain the regression line for the plot, and provide the equation of the fit on the graph.

   e. According to Stokes' law, $F_{Drag}=3\pi\mu DV$ (where D is diameter and V the sinking velocity). Divide the slope you got above (for the regression line) by 3π to obtain an estimate of the viscosity of glycerin (μ). How does it compare with published values? (Feel free to use the WWW, and notice that the viscosity of glycerin varies strongly with temperature)

2. Choose two organisms, one whose swimming is associated with low Reynolds number and the other with high Reynolds number. Describe how their swimming strategies and morphologies match the flow regimes they operate in (20/100).
For each organism, use and cite at least one reference that discusses its swimming.

3. (20/100) Based on the movie 'low Reynolds number flow':

a. What high Reynolds number swimming strategy fails at low Reynolds number?

b. How are falling (or rising) particles affected by the presence of walls and adjacent particles near them?

c. What is reversibility and how is it related to low Reynolds number flows?

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