SMS-204: Integrative marine sciences.

Homework 5, Reynolds #, flows and swimming.

1. (60/100) Fill in the first two columns in the table below with data from Lab 1 (can be found on the lab website or in the answers to Homework 1). Provide units. Fill out the rest of the table by doing the following:
   Be careful to convert to consistent units!

Bead Diameter	Sinking	Velocity x Diameter	Reynolds Number (unitless)	Drag Force (newtons)

a. (10pts) 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. (10pts) 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. (15pts) Plot F_{drag} (based on the equation above) as function of sinking velocity times diameter. Is the relationship linear (don't forget to add error bars based on the different estimates for velocity obtained by the different groups)?

d. (15pts) Obtain the regression line for the plot, that is an expression of the type: F_{drag}= slope x sinking velocity x diameter + constant, and provide the display of the fit on the graph

e. (10pts) 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. Watch two of the following movies and describe how the swimming, feeding or spore release strategy and morphology of each of the two organisms you chose match the flow regimes (in terms of Reynolds number) it operates in (20/100).

Vortices formed around a starfish larvae to enhance feeding:
https://gfm.aps.org/meetings/dfd-2016/57d648ebb8ac3117910005f9

Bacteria flagella:
https://gfm.aps.org/meetings/dfd-2016/57da1549b8ac3117910009ed

Jelly fish:
https://www.youtube.com/watch?v=StCfjFXQy24

Trout swimming upstream:
https://gfm.aps.org/meetings/dfd-2016/57db4473b8ac311791000b19

Unusual microscopic swimmer (Cercariae):
http://gfm.aps.org/meetings/dfd-2014/5416413369702d585c3f0100

Spore release:
http://gfm.aps.org/meetings/dfd-2014/5416731e69702d585c750100

Nematod swimming
http://gfm.aps.org/meetings/dfd-2014/54174d3369702d585c040300

Antartica 'butterfles' swimming
https://gfm.aps.org/meetings/dfd-2015/55f63e2669702d060df00300

3. Movie analysis (20/100): Watch the movie 'life at low Reynolds number' (https://www.youtube.com/watch?v=gZk2bMaqs1E).

a. What are the two swimming motors/appendages used by organisms at low Reynolds numbers?

b. What is the dominating force at low Reynolds number?

c. What fluid should we swim in to have a similar Reynolds number as the one of the swimming Rotifer in the movie?

This page was last edited on 2/16/2017