

Fields, Forces and Flows in Biological Systems, Spring 2007

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Problem Set #1

Issued: Friday, February 9

Due: Friday, February 16

Questions (10 points each)

1. A metal bead is dropped in a large tank filled with glycerin, and velocity of bead was measured. Now, the same experiment was repeated, but this time the bead was dropped near the wall of the tank (within a distance approximately the same as the radius of the bead) vertically. In this experiment, do you expect the falling velocity of the bead to be higher, lower, or the same? Briefly explain.

2. Bird / Stewart / Lightfoot Chapter 2, page 62, exercise 11

3. A flow field $\mathbf{v}(x, y, z)$ is said to be irrotational if curl of the field is zero. Which of the following fields are irrotational?
 - a) $v_x=y, v_y=0, v_z=0$
 - b) $v_x=y, v_y=x, v_z=0$
 - c) $v_x=-y, v_y=x, v_z=0$

Choose one irrotational flow field and one rotational flow field from above, and sketch the direction of the flow near the origin ($x=y=z=0$).

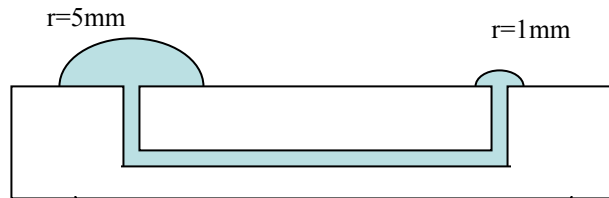
Problems (20 points each)

1. *Haus and Melcher website*

Problem 2.2.1

http://web.mit.edu/6.013_book/www/chapter2/2.prob.html

3. A microfluidic channel has two openings as shown below, and is filled with water. Using the pipette, two spherical droplets, with the radius of 1mm and 5mm each, were put down at the openings.



- a) What will happen to the two drops? Explain briefly.
- b) Calculate the pressure difference between the two drops. The surface tension γ for water is 0.0728 N/m .