Fluid Mechanics – Tutorial Sheet #1

This tutorial sheet is not graded. We will cover this tutorial on Monday, 15 August. If you need any help drop by PAP-05-13 and ask for Julien or send an email to JULIEN001@e.ntu.edu.sg, please start emails subject with PH3501.

You are requested to hand in your work as a Jupyter Notebook. For more information on the submission rules refer to "Logistics and introduction" PowerPoint by Prof. Ohl.

Help: you can find some help for this tutorial in the Notebook: Tutorial 1 – Help Notebook.

1 – Molecular dynamics (MD) simulations

For this first part, you will be using the MD program introduced in the Teaser Video 1. You can find it and run it in your browser from the following website: http://cav2012.sg/cdohl/ph3501/md/.

For more information on how to run the program have a look to Prof Schroeder Website: http://physics.weber.edu/schroeder/md/ , please note that his version does not have the pressure graph.

Your task is to play with program and to identify the four following states:

- Solid state (may be surrounded with gas)
- Liquid state (may be surrounded with gas)
- Real gas state
- Perfect gas state

Take screenshots for each of the states and insert it in a Python Notebook accompanied with brief justification.

2- Familiarization with Jupyter

In the same Notebook, please complete the following tasks:

- Plot a circle of radius 5 centered on (0,0).
- Plot the profile of the hydrostatic pressure in water between the surface and a depth of 10m. Please add a title, axis labels and a legend.
  Hint: Pressure = (density of liquid) x (acceleration gravity) x (height)

3- Einstein summation convention (taken from Prof. Ohl's Math Refresher)

$$\vec{a} = \mathbf{a} = \begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix} = (a_1, a_2, a_3)^T \qquad \underline{\underline{\mathbf{A}}} = A_{ij} = \begin{pmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{pmatrix}$$

Write the multiplication $\mathbf{a}\underline{\underline{\mathbf{A}}}$ and $\underline{\underline{\mathbf{A}}}\mathbf{a}$ using Einstein summation convention.

Hint: Write it first as a sum using the ∑- symbol.