SMS 204: Integrative Marine Sciences, Physics/chemistry

- Instructors: E. Boss and M. J. Perry
- Credits: 2
- Meeting times: Mon. 1:10-2pm – Aubert Hall
- Labs: 2:10-4:00, 4:10-6:00 – Aubert Hall
- If you need any assistance, please contact me.
- Email: emmanuel.boss@maine.edu
- Class web site:
  http://misclab.umeoce.maine.edu/boss/classes/SMS_204_2007/Syllabus.htm
• **Class philosophy**
  - Physics and chemistry are needed to understand the environment organisms face.
    - Learn some basic concepts
    - Gain hands-on experience
  - Create a supportive learning environment and learning community
  - Learn necessary skills:
    - Displaying data
    - Analyze data (statistics)
    - Relate different data
• **Expectations**
  - Listen/interact in class. If you don’t slow me with questions I will charge on…
  - Come see me if you need to (Thu. am official office hours, Aubert, 458) or drop me an email.
  - Homework (can work in group, hand-in individually)
  - 2 exams (one for each module)

• **Class notes are on-line a week prior to the lecture. I expect you to read them before the coming to class. I may quiz you on them.**
• What is physics?


- The study of how objects (from the very tiny to the very big) behave. [web.mala.bc.ca/webquests3/Save%20Human%20Race/glossary_text.html](http://web.mala.bc.ca/webquests3/Save%20Human%20Race/glossary_text.html)

- The word physics is derived from Greek word fusis, meaning nature or natural things. As such, physics is defined as that branch of science, which studies natural phenomena in terms of basic laws and physical quantities. ...Physics answer questions about universe and the way elements of universe interact to compose natural phenomena. [http://cnx.org/content/m13250/latest/](http://cnx.org/content/m13250/latest/)
• What activities define biological organisms?

- Reproduction (find mate)
- Feeding (find food)
- Get rid of waste products
- Avoid being eaten (escape)
• What do we need to know about the environment marine organisms experience?

• Choose two marine organisms (one about 1-10m the other about 0.1-1cm).

• Provide physical characteristics of the environments which affect:
  - Reproduction (finding a mate)
  - Feeding (finding food)
  - Getting rid of waste products
  - Avoiding being eaten (escape)
• Some basic concepts we need before we get into physics

- Dimensions and units (How much?)
- Coordinate system (Where?)
- Accuracy vs. precision (How well do we know something?)
- Statistics: data description.
• Dimensions and Units

- T, L & M (sec, m & Kg, SI units).
- Consistency in dimensions is crucial in physics and can highlight dependencies (dimensional analysis).
- Table with dimensions of different physical quantities in the notes.
Coordinate system, and some basic notation.

Vectors and scalars

\[ L = \sqrt{(x_1 - x_0)^2 + (y_1 - y_0)^2 + (z_1 - z_0)^2} \]
• Measurements, precision, and accuracy
  - Every measurement has an uncertainty
  - May depend on measuring device
  - Two sources for uncertainty:
    • Precision: how well can we reproduce a measurement
    • Accuracy: how close we are to the ‘true’ value
Two definitions to impress your friends:

- **Precision**: the variability of a set of measurements.
- **Accuracy**: how close the measurements are to the ‘correct’ value.

From: http://www.cc.gla.ac.uk/courses/science/shc/image17D.JPG
Basic statistics:
A mathematical set of tools to describe observations.

Two different observations pertaining to a hypothetical distribution of the size of adult salmon, both having the same average size:
Basic statistics:

Two different ways to describe observations:

• Parametric statistics (e.g. average, standard deviation, etc’). Have meaning when underlying distribution is known.

• Non-parametric statistic (data are ranked. median, percentiles).
• **Solids and fluids**
  - Self supporting solids vs. container supported fluids.
  - Liquid vs gas (fill or not the container in which they are).
  - Different response to an applied stress (F/A):
    - **Solids**: $\tau = G\theta$
    - **(Newtonian) Fluids**: $\tau = \mu \frac{d\theta}{dt}$
• Continuum hypothesis: we treat fluids as continuous medium disregarding their molecular nature.

• Some physical properties have their origins in the molecular nature of the fluid (e.g. density, temperature and viscosity).

• Fluids ‘stick’ to surfaces (no matter how smooth): No-slip condition.
Summary:

- We should study physics to better understand the biology of marine organisms.

- We need to keep track of units of physical quantities.

- We need to keep track of uncertainties in physical measurements.

- It is convenient to treat liquids as continuous medium (without holes between the molecules).

- Liquids differ from solids and gases in fundamental ways.