SMS 204: Integrative marine sciences II

• Instructors: E. Boss and MJ Perry (2nd module).

• Last week’s homework.

Issues: measurements & uncertainties.

• Class web site:
  http://misclab.umeoce.maine.edu/boss/classes/SMS_204_2006/Syllabus.htm
• Some important concepts from last week:
  - Hydrostatic pressure: weight of water/area
  - Continuity $V \times A = \text{constant}$
• Archimedes's principle:
  - The buoyancy force is equal to the weight of the liquid displaced by the object.

For a floating object:

\[ F_{\text{buoyancy}} = V_{\text{displaced}} \rho_{\text{water}} g \]

\[ ma = F_{\text{gravity}} - F_{\text{buoyancy}} = 0 \]

What is the balance of forces for a sinking object?
Center of buoyancy vs. center of gravity:

Center of gravity:

\[ \vec{r}_c = \sum_i \frac{\vec{r}_i m_i}{m_i} \]

Center of buoyancy:

Center of gravity of displaced fluid.

When center of buoyancy is below the center of gravity the situation is unstable.

Separate centers of gravity and buoyancy allow organisms and plants to orient relative to the gravitational field: e.g. dinoflagellates, kelp.
• Buoyancy issues for marine organisms:

• Blubber is buoyant
• Muscles and bones are heavy
• Air is buoyant (but compressible)

Some strategies:
• Air in stomach (some sharks).
• Swim bladder (many bony fishes, physiologically regulated).
• Large oily liver (Sharks).
• **Energy:**
  - Capacity to do work (force x distance).

• **Kinetic energy:** $mv^2/2$

• **Pressure-volume energy:** $PV$

• **Potential energy:** $mgh$

• **Other:** internal energy, heat.

• **Conservation of energy per unit mass:**
  - Neglecting friction (heat)

$$\frac{v^2}{2} + gh + \frac{P}{\rho} = \text{constant} \quad \text{(Bernoulli’s principle)}$$
• Fluid’s ‘head’: energy per unit mass/g. Divided into static, velocity, and pressure head.

\[ z_1 = \frac{u_2^2}{2g} + \frac{p_2}{\rho g} + z_2 \]

Friction causes loss of head. Where does the energy go?
• Squirtive column:

\[ \rho gh \]

\[ \rho u^2/2 \]
Application: flow above a disturbance (Clams, ripples, houses, etc’).
Skills: reporting significant figures (see handout)

The number of figures used to describe a quantity suggests the accuracy to which it is known.

In science, stating that
\[ x = 1.3 \]
means that you are confident that
\[ 1.35 > x > 1.25. \]

Had you written \( x = 8 \times 10^3 \), then it suggests \( 8500 > x > 7500 \) (a 6% uncertainty), while \( x = 8.0 \times 10^3 \) means \( 8050 > x > 7950 \) (a 0.6% uncertainty).

‘Rounding’ is the practice of changing numbers to a close relevant number.