13.012 Marine Hydrodynamics for Ocean Engineers
Prof. Alex Techet
Fall 2004

HW #1
Out: 14 Sept 2004
Due: 21 Sept 2004

Problem 1:

Determine the Reynolds number of the following objects:

a) A baseball pitched by a professional baseball player
b) A swimming hammerhead shark
c) A swimming tadpole
d) A navy aircraft carrier
e) A Tech Dinghy

Estimate the appropriate length and velocity scales.

Problem 2:

At a particular point in the Pacific Ocean, the density of sea water increases non-linearly with depth according to

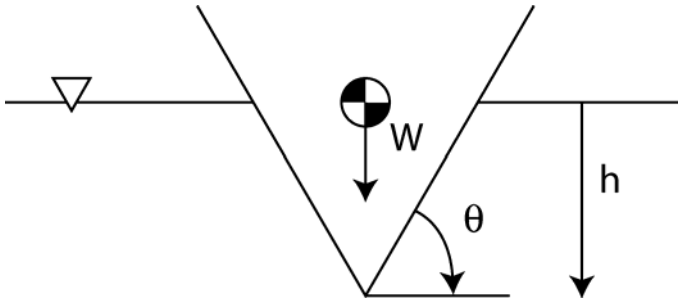
$$\rho = \rho_o + \tfrac{1}{2} m z^2$$

where ρ_o is the density at the surface, z is the depth below the surface, and m is a constant. Develop an algebraic equation for the relationship between pressure and depth.

Problem 3:

a) Determine the horizontal and vertical forces acting on a wall sloped at angle, θ, to the horizontal seafloor as a function of z. Assume that the water is h deep and that atmospheric pressure acts everywhere.
b) Determine the total resulting force and center of pressure.
c) If the wall has a 10º slope and the water is 15 meters deep, determine the moment acting at the base of the wall.

Problem 4: Archimedes Principle on a floating vessel



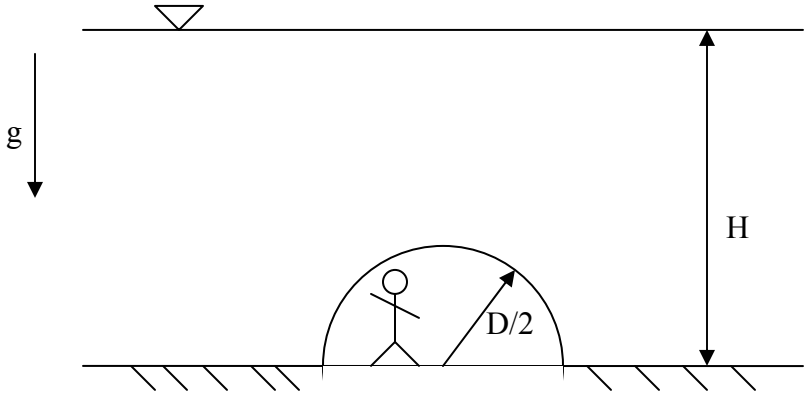
Extend the results you found in problem 3 to the case of a "V" shaped vessel floating on the surface of the ocean to prove that the resulting pressure acting on the hull balances the weight of the water displaced by the vessel.

Problem 5:

A rectangular barge floats in water, ρ_w. When it is empty it is immersed at depth D below the surface. Oil with density, ρ_o, is poured into the barge until it is about to sink. Find a relationship for the depth of the oil at this point in terms of the initial depth, D, the total height of the barge H and the barge width W.

Problem 6:

You are asked to design an underwater laboratory at the bottom of the Gulf of Mexico, in order to study the habits of Migrating Whale Sharks. After attending a lecture given by Samuel Raymond, founder of Benthos, you realize that a spherical structure would be ideal for this project. So you have decided that the laboratory will be built as a hemi-sphere off the sea floor and sketch the following concept design:



a) What is the distribution of pressure over the wetted surface of the laboratory?

b) What are the total fluid force and moment vectors exerted on the laboratory by the surrounding fluid?

Give your answers in terms of given variables and fluid properties.