



2.016 Hydrodynamics
Prof. Alex Techet
Fall 2005

HW #1
Out: 13 Sept 2005
Due: 20 Sept 2005

Problem 1:

Which of the following are isotropic? Why or why not?

- a) Temperature
- b) Pressure
- c) Shear stress
- d) Dynamic viscosity

Problem 2:

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

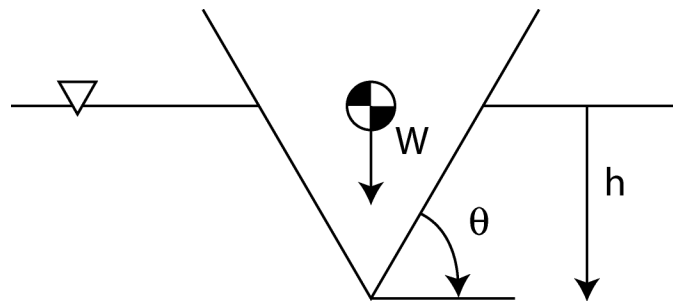
$$\rho = \rho_o + mz^2$$

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.

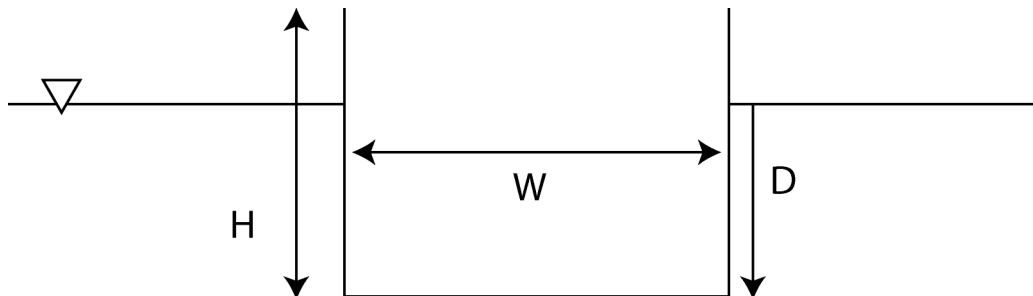
Problem 4: Archimedes Principle on a floating vessel



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

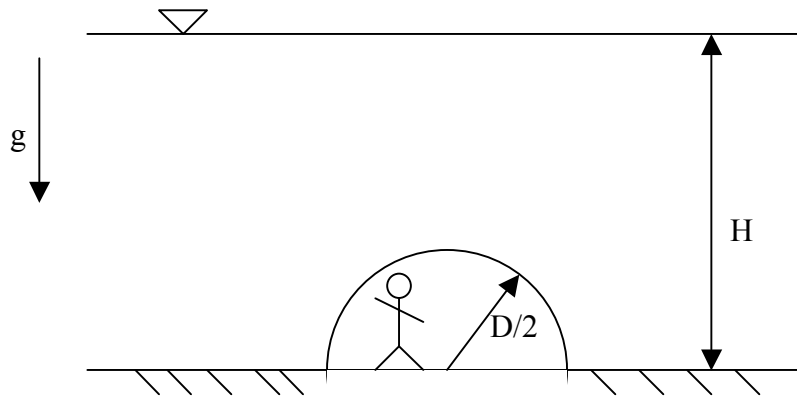
Problem 5:

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 hemisphere 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?