Sample Midterm – Fluid Mechanics with Diogo Bolster

4 Questions, Each 25 Points

Q1) 5 multiple choice Problems

A) The use of Bernoulli's equation along a streamline does *not* imply that

[Streamlines are not curved] [Energy is conserved in the flow]

[Flow is steady in time]

B) Oil fills the narrow gap δ between a fixed plate and a plate moving at velocity V_1. The velocity profile is then $u=V_1(y/\delta)$. For an oil with viscosity μ, the shear stress is found to be τ. What will be the shear stress if the gap is filled instead by an oil with viscosity 2μ, and the velocity profile is exactly the same?

[$\tau/4$] [$\tau/2$] [$\tau/2^{1/2}$] [τ]

[$\tau*2^{1/2}$] [2τ] [4τ].

C) A compressible fluid (gas) stored in a rigid tank is heated from temperature T_1 to T_2, where $T_2>T_1$. The density, ρ, of the fluid at temperature T_2 will be

[greater than at T_1] [the same as at T_1] [less than at T_1].

D) Which of these properties will change as water in a sealed bottle with no air space moves from the earth to the moon? Assume that the temperature and pressure remain constant.

[Density] [Specific Weight] [Dynamic Viscosity]

[Kinematic Viscosity] [Bulk Modulus] [None will change].

E) A dam has a water depth of h which produces a hydrostatic force F on the dam face. If the water depth doubles to 2h, the hydrostatic force on the dam face will then be

[F/4] [F/2] [$F/2^{1/2}$]

[F] [$F*2^{1/2}$] [2F] [4F]

Q2) Fundamental Properties of Fluids

According to information from an old hydraulics book, the energy loss per unit weight of fluid flowing through a nozzle connected to a hose can be estimated using these formula depending on the ratio D/d:

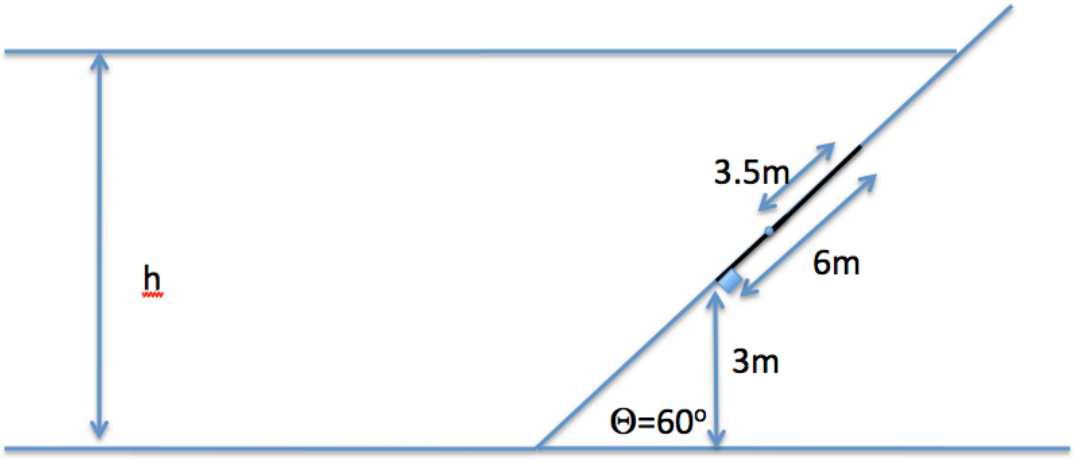
$h=0.04\ (D/d)^4V^2/2g$ for D/d in regime 1

$h=0.7\ (D/d)^4V^3/2g$ for D/d in regime 2

h is the energy loss per unit weight, D is the hose diameter, d is the nozzle tip diameter, V is the velocity of the hose and g the acceleration due to gravity. Do you think these equations are valid in any system of units? Explain!

Q3) Hydrostatics

A rectangular gate with width 4m and length 6m is located in a sloping tank as depicted. The gate has a shaft 3.5m down from its top as depicted. The gate is designed to rotate open once the water level reaches a certain height. At what height will this happen? What is the magnitude of the force when that happens? Would this height h be greater, smaller or the same if the fluid of depth h were oil with SG=0.8 (specific gravity)?



Q4) Bernoulli

Water flows steadily with negligible viscous effects through the pipe shown in the figure. Determine the diameter of the pipe at the outlet (a free jet) if the velocity there is 6 m/s