NAME (print): _____

CVEN 311-502 Fall 2009
Examination 1
October 5, 2009
7:00 pm – 8:40 pm

This is a closed-book examination. You are allowed to use one letter-sized (8 ½" x 11") formula sheet with writing on one side only. No examples, problems, or solutions are allowed on your formula sheet. ***To receive full credit on this examination, you must turn in your formula sheet with your examination.*** The formula sheet will be returned to you with your graded exam.

All exam problems have the value indicated. ***The total number of points is 100 for the 100 minute exam duration.*** For full credit, you must show ALL work for workout problems, including free-body diagrams, general and specific forms of equations, and all assumptions; be sure your work is legible and CLEARLY indicate your final answer. FE-type multiple choice problems will be graded solely on your selected multiple choice responses.

Be sure to sign the Aggie Honor statement below and that you print your name above and on your formula sheet. Good luck!

I pledge that I have neither given nor received aid in completing this exam. I have followed the strictures of the Texas A&M University Aggie Code of Honor during this test period.

Signature: _____

Properties of Liquids (BG Units)

Liquid	Temp. (^{0}F)	Density ρ (slugs/ft^3)	Specific Wt. γ (lb/ft^3)	Dyn. Viscosity μ (lb-s/ft^2)	Surface Tension σ (lb/ft)
Carbon Tetrachloride	68.0	3.09	99.50	2.00E-5	1.84E-3
Ethyl Alcohol	68.0	1.53	49.30	2.49E-5	1.56E-3
Gasoline	60.0	1.32	42.50	6.50E-6	1.50E-3
Glycerin	68.0	2.44	78.60	3.13E-2	4.34E-3
Mercury	68.0	26.30	847.00	3.28E-5	3.19E-2
SAE 30 motor oil	60.0	1.77	57.00	8.00E-3	2.50E-3
Seawater	60.0	1.99	64.00	2.51E-5	5.03E-3
Water	60.0	1.94	62.40	2.34E-5	5.03E-3

Properties of Liquids (SI Units)

Liquid	Temp. (^{0}C)	Density ρ (kg/m^3)	Specific Wt. γ (kN/m^3)	Dyn. Viscosity μ (N-s/m^2)	Surface Tension σ (N/m)
Carbon Tetrachloride	20.0	1590	15.60	9.58E-4	2.69E-2
Ethyl Alcohol	20.0	789	7.74	1.19E-3	2.28E-2
Gasoline	15.6	680	6.67	3.10E-4	2.20E-2
Glycerin	20.0	1260	12.40	1.50E+0	6.33E-2
Mercury	20.0	13600	133.00	1.57E-3	4.66E-1
SAE 30 motor oil	15.6	912	8.95	3.80E-1	3.60E-2
Seawater	15.6	1030	10.10	1.20E-3	7.34E-2
Water	15.6	999	9.80	1.12E-3	7.34E-2

Properties of Air:

Density at standard atmospheric pressure ρ: 2.38E-3 slugs/ft^3 (BG)
1.23E+0 kg/m^3 (SI)

Specific Weight at standard atmospheric pressure γ: 7.65E-2 lb/ft^3 (BG)
1.20E+1 N/m^3 (SI)

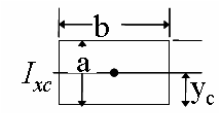
Gas Constant *R*: 1.716E+3 ft-lb/slug-^{o}R (BG)
2.869E+2 J/kg-^{o}K (SI)

Standard Atmospheric Pressure: 2116.2 lb/ft^2, abs (BG)
101.33 kPa, abs (SI)

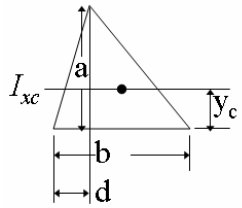
Some conversion factors and constants:

Degrees Rankine = Degrees Fahrenheit + 459.67 (BG)
Degrees Kelvin = Degrees Celsius + 273.15 (SI)
$g = 32.2\ ft/s^2 = 9.81\ m/s^2$
1 ft. = 12 in.
1 m = 100 cm = 1000 mm
$1\ ft^2 = 144\ in^2$

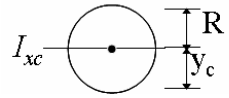
NOTE: Assume gage pressures unless otherwise noted.



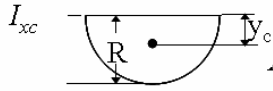
$$A = ab \qquad y_c = \frac{a}{2} \qquad I_{xc} = \frac{ba^3}{12} \qquad I_{xyc} = 0$$



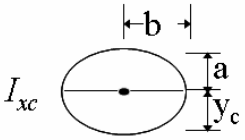
$$A = \frac{ab}{2} \qquad y_c = \frac{a}{3} \qquad x_c = \frac{b+d}{3} \qquad I_{xc} = \frac{ba^3}{36} \qquad I_{xyc} = \frac{ba^2}{72}(b-2d)$$



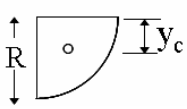
$$A = \pi R^2 \qquad y_c = R \qquad I_{xc} = \frac{\pi R^4}{4} \qquad I_{xyc} = 0$$



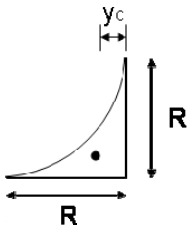
$$A = \frac{\pi R^2}{2} \qquad y_c = \frac{4R}{3\pi} \qquad I_{xc} = \frac{\pi R^4}{8} \qquad I_{xyc} = 0$$



$$A = \pi ab \qquad y_c = a \qquad I_{xc} = \frac{\pi ba^3}{4} \qquad I_{xyc} = 0$$



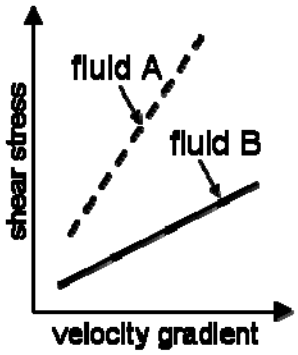
$$A = \frac{\pi R^2}{4} \qquad y_c = \frac{4R}{3\pi} \qquad I_{xc} = \frac{\pi R^4}{16}$$



$$A = R^2\left(1 - \frac{\pi}{4}\right) \qquad y_c = 0.223R$$

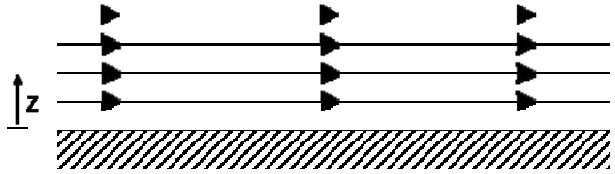
Part FE – FE-type Multiple Choice Problems (5 problems totaling 25 points). CLEARLY circle your answer. ANSWERS: ACDCB

FE-1 (5 points). Experimental data of shear stress and velocity data were collected for two different fluids, fluid A and fluid B, and the results are plotted below. Which of the following statements is true?



(a) Fluids A and B are Newtonian fluids, and the absolute viscosity of A is greater than B
(b) Fluids A and B are Newtonian fluids, and the absolute viscosity of A is less than B
(c) Fluids A and B are non-Newtonian fluids, and the absolute viscosity of A is greater than B
(d) Fluids A and B are non-Newtonian fluids, and the absolute viscosity of A is less than B

FE-2 (5 points). The ***vertical*** pressure variation for the flow whose streamlines are shown below is ***best*** described by which of the following equations?



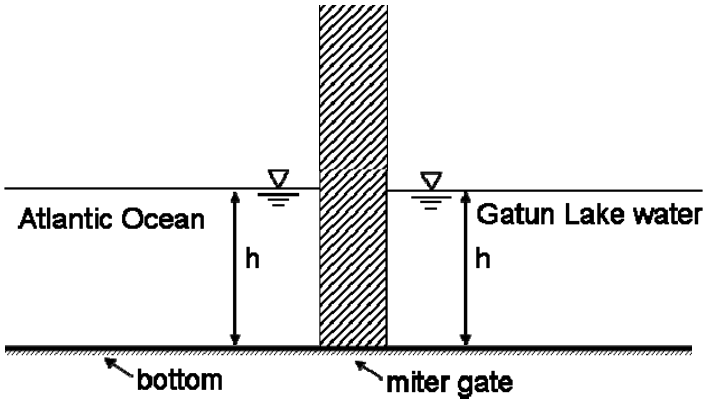
(a) $\left(\frac{p}{\gamma}+z\right)\Big|_1^2 = \int_1^2 \frac{V^2}{R}\,dn$

(b) $\frac{p}{\gamma}+\frac{V^2}{2g}+z=\text{constant}$

(c) $\frac{p}{\gamma}+z=\text{constant}$

(d) $p=\text{constant}$

FE-3 (5 points). Consider the Panama Canal. The *fresh* water level inside the Gatún Lock is lowered to match the Atlantic Ocean *salt water* level, as shown. The net hydrostatic pressure force on the miter gate is:



(a) to the left (←) and is located at 0.5*h* above the bottom.
(b) to the right (→) and is located at 0.5*h* above the bottom.
(c) to the left (←) and is located at 0.33*h* above the bottom.
(d) to the right (→) and is located at 0.33*h* above the bottom.

FE-4 (5 points). The specific gravity of the concrete mixture being used to construct the new bridge at the intersection of Harvey Mitchell and Wellborn is 2.5. The density of the concrete mixture is most nearly:

(a) 12.3 kg/m^3
(b) 24.5 kg/m^3
(c) 2,500 kg/m^3
(d) 24,500 kg/m^3

FE-5 (5 points). A party balloon is filled with helium (R = 2.466E+4 ft·lb/slug·^oR) at 60^oF. If we assume that the pressure inside the balloon equals the pressure outside the balloon, the helium density inside the balloon is most nearly:

(a) 0 slug/ft^3
(b) 1.65E-4 slug/ft^3
(c) 2.58E-4 slug/ft^3
(d) 1.43E-3 slug/ft^3

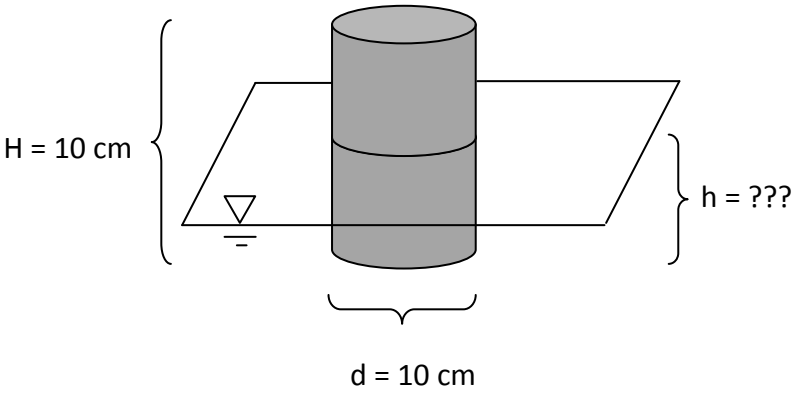
Part WO – Work Out Problems (5 problems totaling 75 points). For full credit clearly show all work and clearly mark your final answer.

WO-1 (15 points): Bathroom Fluid Mechanics, Part I

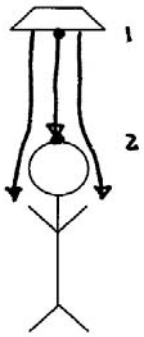
The lever on a toilet tank operates a mechanism that lifts a bar connected by a chain to a stopper in the bottom of the tank. This removes the stopper and releases the water into the bowl below. *Find the torque that must be applied at Point 1 to release the stopper.* The circular rubber stopper is 4 inches in diameter, the height of the water in the tank is 18 inches, and the length of the connecting bar to the chain is 15 inches. Neglect the weight and height of the stopper. (*10 points*) ANSWER: T = 10.2 ft-lb

a) After the tank is flushed, the stopper closes and another mechanism activates to refill the tank. This mechanism is guided by a float that tracks the water elevation in the tank. Find the depth (h) to which this cylindrical float is submerged if it has a density of 350 kg/m^3, a height of 10 cm, and a diameter of 5 cm. (*5 points*)

ANSWER: h = 3.5 cm



WO-2 (10 points): Bathroom Fluid Mechanics, Part II



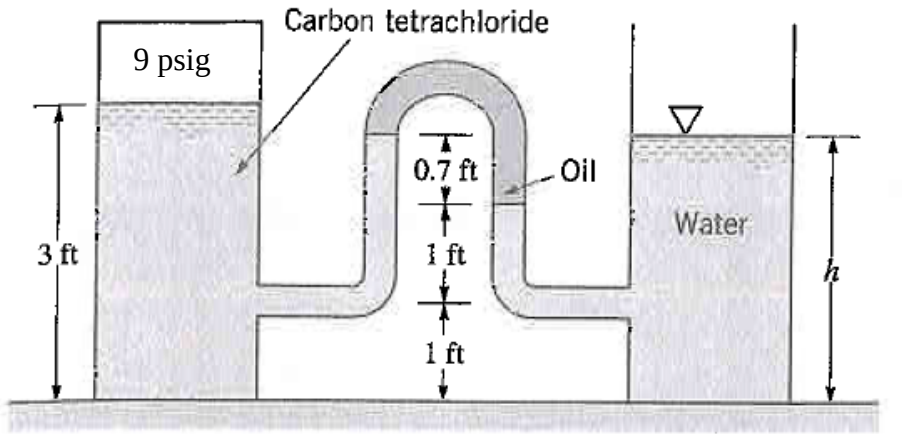
Water flows freely out of your shower head at a velocity of 3 m/s. As you stand under it, water hits the top of your head. What is the pressure (P_2) of the water as it hits the very top of your head? You are 1.68 m tall and the shower head is located 2 m above the floor of the shower.

ANSWER: P_2 = 7.6 kPa

WO-3 (10 points): Man, oh, man…more manometers

An inverted U-tube manometer containing oil (S.G. = 0.8) is located between two tanks. The tank on the left contains carbon tetrachloride and is pressurized to 9 psig. The tank on the right contains water and is open to the atmosphere. Given the measurements shown below, what is the height, *h*, of water in the tank on the right? Note that the water level in the drawing might not be shown "to scale".

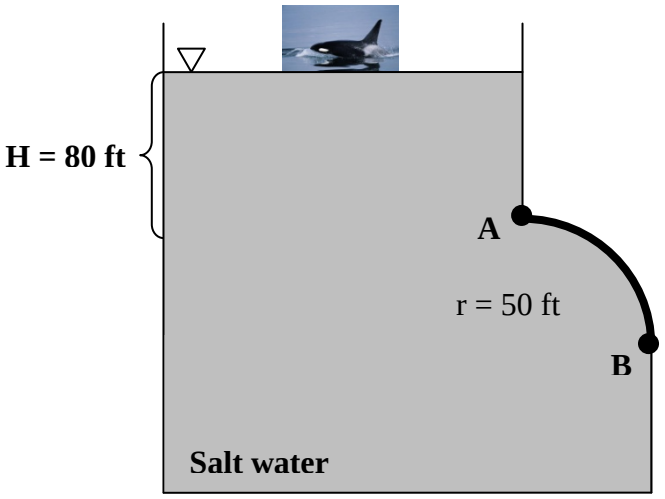
ANSWER: h = 23.8 ft.



WO-4 (20 points). A Whale of a Problem

A tank holding salt water (and Shamu, the killer whale) has a cylindrical window spanning from Point A to Point B and going into the page. The window starts 80 ft below the surface of the water and has a radius of 50 ft. The tank has a width of 100 ft into the paper.

a) Sketch and label all relevant forces on a control volume of the fluid. (*5 points*)
b) Determine the resultant vertical and horizontal hydrostatic forces on the gate and the location where they act. (*15 points*) ANSWER: $F_H = 3.36 \times 10^7$ lb, $F_v = 2.90 \times 10^7$ lb, $x_v =$ 26.7 ft right of A, $x_H = 107$ ft from surface.



WO-5 (20 points). A shaft with a square cross-section is pulled steadily at velocity, v = 0.4 m/s through a square sleeve, as shown. The clearance, assumed to be uniform on all sides, is filled with oil. Estimate the force required to pull the shaft. The oil viscosity is 0.38 N·s/m^2. ANSWER: 146 N