Name: ____

CVEN 311 – Fluid Dynamics
Fall Semester 2008
Dr. Kelly Brumbelow, Texas A&M University

Midterm Exam #1

Closed-book, Closed-notes, Formula sheet allowed (5 pages, 3 questions)
Time allowed: 75 minutes

Reference tables

Approximate Physical Properties of Some Common Liquids (BG Units)

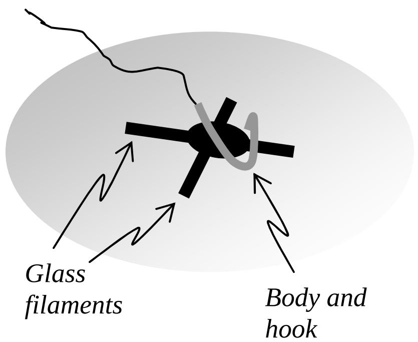
Liquid	Temperature (°F)	Density, ρ (slugs/ft^3)	Specific Weight, γ (lb/ft^3)	Dynamic Viscosity, μ (lb · s/ft^2)	Kinematic Viscosity, ν (ft^2/s)	Surface Tension,[a] σ (lb/ft)	Vapor Pressure, p_v [lb/in.^{2} (abs)]	Bulk Modulus,[b] E_v (lb/in.^{2})
Carbon tetrachloride	68	3.09	99.5	2.00 E − 5	6.47 E − 6	1.84 E − 3	1.9 E + 0	1.91 E + 5
Ethyl alcohol	68	1.53	49.3	2.49 E − 5	1.63 E − 5	1.56 E − 3	8.5 E − 1	1.54 E + 5
Gasoline[c]	60	1.32	42.5	6.5 E − 6	4.9 E − 6	1.5 E − 3	8.0 E + 0	1.9 E + 5
Glycerin	68	2.44	78.6	3.13 E − 2	1.28 E − 2	4.34 E − 3	2.0 E − 6	6.56 E + 5
Mercury	68	26.3	847	3.28 E − 5	1.25 E − 6	3.19 E − 2	2.3 E − 5	4.14 E + 6
SAE 30 oil[c]	60	1.77	57.0	8.0 E − 3	4.5 E − 3	2.5 E − 3	—	2.2 E + 5
Seawater	60	1.99	64.0	2.51 E − 5	1.26 E − 5	5.03 E − 3	2.26 E − 1	3.39 E + 5
Water	60	1.94	62.4	2.34 E − 5	1.21 E − 5	5.03 E − 3	2.26 E − 1	3.12 E + 5

TABLE 1.7
Approximate Physical Properties of Some Common Gases at Standard Atmospheric Pressure (BG Units)

Gas	Temperature (°F)	Density, ρ (slugs/ft^3)	Specific Weight, γ (lb/ft^3)	Dynamic Viscosity, μ (lb · s/ft^2)	Kinematic Viscosity, ν (ft^2/s)	Gas Constant,[a] R (ft · lb/slug · °R)	Specific Heat Ratio,[b] k
Air (standard)	59	2.38 E − 3	7.65 E − 2	3.74 E − 7	1.57 E − 4	1.716 E + 3	1.40
Carbon dioxide	68	3.55 E − 3	1.14 E − 1	3.07 E − 7	8.65 E − 5	1.130 E + 3	1.30
Helium	68	3.23 E − 4	1.04 E − 2	4.09 E − 7	1.27 E − 3	1.242 E + 4	1.66
Hydrogen	68	1.63 E − 4	5.25 E − 3	1.85 E − 7	1.13 E − 3	2.466 E + 4	1.41
Methane (natural gas)	68	1.29 E − 3	4.15 E − 2	2.29 E − 7	1.78 E − 4	3.099 E + 3	1.31
Nitrogen	68	2.26 E − 3	7.28 E − 2	3.68 E − 7	1.63 E − 4	1.775 E + 3	1.40
Oxygen	68	2.58 E − 3	8.31 E − 2	4.25 E − 7	1.65 E − 4	1.554 E + 3	1.40

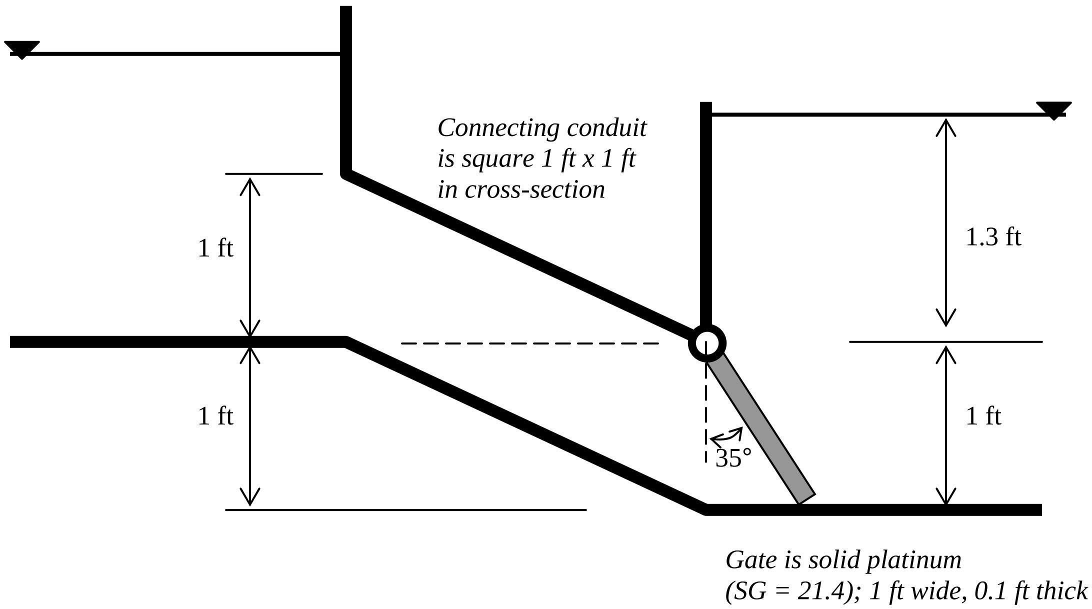
[a]Values of the gas constant are independent of temperature.
[b]Values of the specific heat ratio depend only slightly on temperature.

1. In flyfishing, a “dry fly” is one which rests on the surface of the water to simulate an insect that is resting there. I am designing my own dry fly to be called the “X-terminator” that is sketched below. My idea is that the X-shaped glass filaments will remain on the water surface due to the water’s surface tension. *What is the maximum weight of the body and hook* that I can add and still have the fly rest on the water surface? (25 points)



2 glass filaments in the X-shaped portion
Filament radius is 0.009 inch
Each filament is 1.0 inch long
Glass SG = 2.6

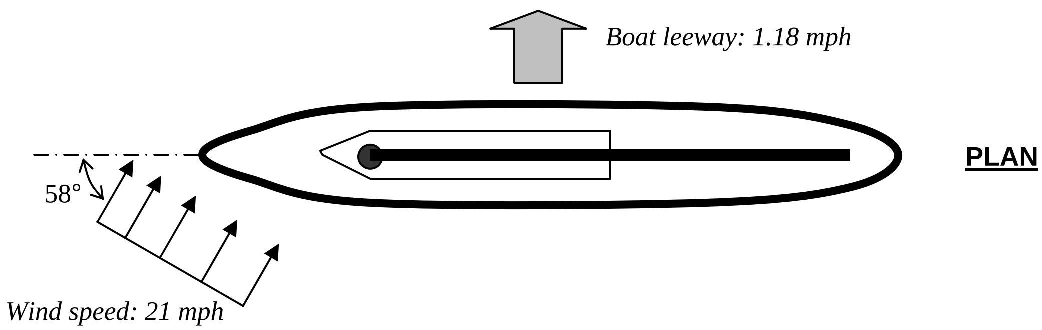
2. Dr. Cahill is currently expanding the fountains on his palatial estate. He is installing 2 new pools and wants to minimize the work to keep them filled with water. He has designed the connecting conduit sketched below with a (frictionless) hinged gate at its end. The weight of the gate will keep it closed until the surface of the left, upper pool is sufficiently above the surface of the right, lower pool. At that point water will flow into the lower pool. *What will be the maximum depth of water in the upper pool for which the gate will remain closed?* (50 points)

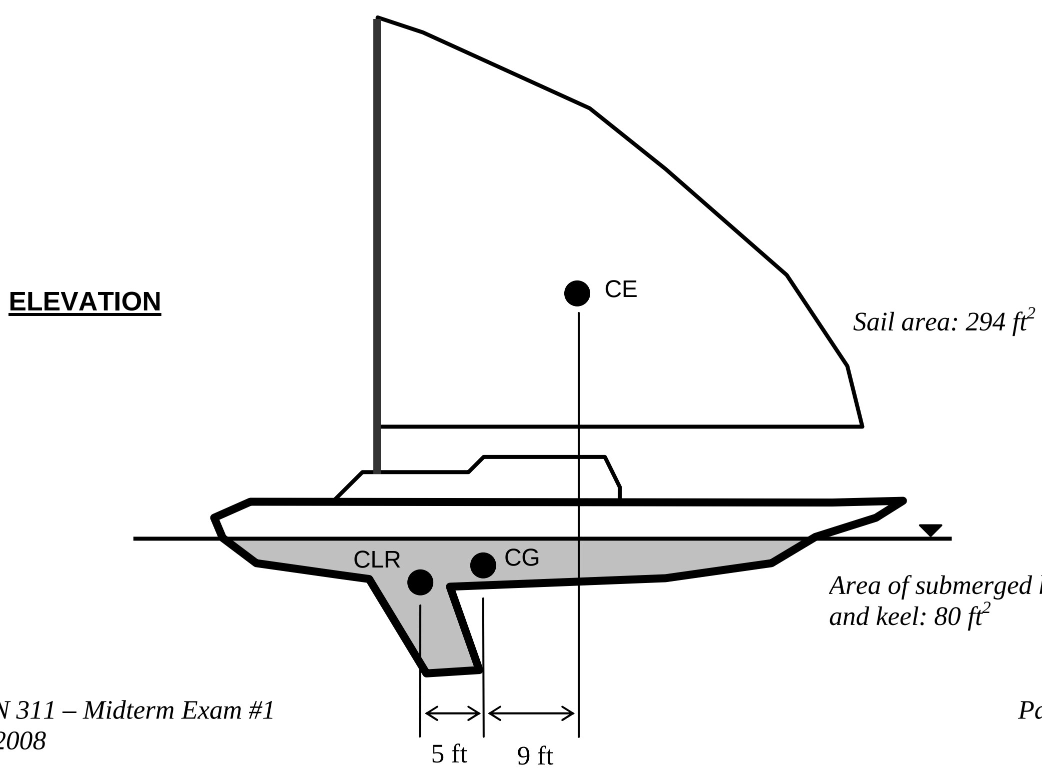


3. In the design of sailboats an important consideration is the relationship of lateral (i.e., sideways) forces and their moments about a boat's center of gravity (CG). The two important forces are (1) the force of wind pushing on the sail and (2) the force of water pushing against the boat's submerged hull and keel in the direction opposite the wind. Both forces can be determined as resultant stagnation pressure forces.

The resultant wind force acts at the boat's "center of effort" (CE) which is the centroid of the sail(s). The second force is a consequence of the boat being pushed sideways by the wind; this "leeway" results in a relative velocity of the boat through the water that can also be considered as an equal and opposite velocity of water towards the boat. This force acts at the "center of lateral resistance" (CLR), which is the centroid of the hull and keel below the surface of the water.

Sketched below is a sailboat with CG, CE, and CLR indicated. Also shown is a plan view of the boat indicating wind direction and speed, boat and sail orientation, and leeway. *What will be the net moment of lateral forces about the boat's CG?* Assume the boat is sailing in seawater.
(25 points)





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