Name:____ Campus Mail Box ____________

Circle One: Richards – 03 Richards – 04 Lui – 05 Lui - 06

Problem 1	(10)	__________
Problem 2	(45)	__________
Problem 3	(45)	__________
TOTAL	(100)	__________

General Comments

(1) Anytime you apply conservation or accounting principles in solving a problem, sketch and clearly identify the system you have selected. In addition, clearly indicate how your assumptions or given information simplifies the general equations. Numbered-symbols, e.g. P_1 ,in equations must make sense for the problem in question, i.e. they must match you figure and communicate information accurately.

(2) Guidelines – Open text book / closed notes; however, you may use the following
... your equation page (single side of 8-1/2 x 11 sheet of paper)
... unit conversion page provide with text
... your computer to run MAPLE, etc, assuming it is *not* communicating with any networks and you are not using any previously prepared worksheets, etc.

(3) For maximum credit,
... solve problems symbolically first showing logic and reasoning for solution,
... substitute numbers into the equations clearly showing any required unit conversion factors
... then and only then crunch numbers on your calculator.
If I only have to punch your numbers into a calculator to get a correct answer (including units) you will receive full credit. **Don't make me guess what you are doing.**

(4) Watch the time and feel free to remove the staple and take the test apart so that you don't have to keep flipping pages around.

PLEASE REMOVE THE STAPLE AND USE EXTRA PAPER *INSTEAD* OF WRITING ON THE BACK OF PAGES AND THEN HAVING TO FLIP BACK AND FORTH TO FINISH THE PROBLEM. I'LL GLADLY RESTAPLE YOUR TEST! **If you remove the staple, *PLEASE* place your name on every page you turn in.**

Length

1 ft = 12 in = 0.3048 m = 1/3 yd

1 m = 100 cm = 1000 mm = 39.37 in = 3.2808 ft

1 mile = 5280 ft = 1609.3 m

Mass

1 kg = 1000 g = 2.2046 lbm

1 lbm = 16 oz = 0.45359 kg

1 slug = 32.174 lbm

Temperature Values

$(T/K) = (T/{}^oR) / 1.8$

$(T/K) = (T/{}^oC) + 273.15$

$(T/{}^oC) = [\,(T/{}^oF) – 32\,]/1.8$

$(T/{}^oR) = 1.8(T/K)$

$(T/{}^oR) = (T/{}^oF) + 459.67$

$(T/{}^oF) = 1.8(T/{}^oC) + 32$

Temperature Differences

$(\Delta T/{}^oR) = 1.8(\Delta T / K)$

$(\Delta T/{}^oR) = (\Delta T/{}^oF)$

$(\Delta T / K) = (\Delta T/{}^oC)$

Volume

1 m^3 = 1000 L = 10^6 cm^3 = 10^6 mL = 35.315 ft^3 = 264.17 gal

1 ft^3 = 1728 in^3 = 7.4805 gal = 0.028317 m^3

1 gal = 0.13368 ft^3 = 0.0037854 m^3

Volumetric Flow Rate

1 m^3/s = 35.315 ft^3/s = 264.17 gal/s

1 ft^3/s = 1.6990 m^3/min = 7.4805 gal/s = 448.83 gal/min

Force

1 N = 1 kg·m/s^2 = 0.22481 lbf

1 lbf = 1 slug·ft/s^2 = 32.174 lbm·ft/s^2 = 4.4482 N

Pressure

1 atm = 101.325 kPa = 1.01325 bar = 14.696 lbf/in^2

1 bar = 100 kPa = 10^5 Pa

1 Pa = 1 N/m^2 = 10^{-3} kPa

1 lbf/in^2 = 6.8947 kPa = 6894.7 N/m^2

[lbf/in^2 often abbreviated as “psi”]

Energy

1 J = 1 N·m

1 kJ = 1000 J = 737.56 ft·lbf = 0.94782 Btu

1 Btu = 1.0551 kJ = 778.17 ft·lbf

1 ft·lbf = 1.3558 J

Energy Transfer Rate

1 kW = 1 kJ/s = 737.56 ft·lbf/s = 1.3410 hp = 0.94782 Btu/s

1 Btu/s = 1.0551 kW = 1.4149 hp = 778.17 ft·lbf/s

1 hp = 550 ft·lbf/s = 0.74571 kW = 0.70679 Btu/s

Specific Energy

1 kJ/kg = 1000 m^2/s^2

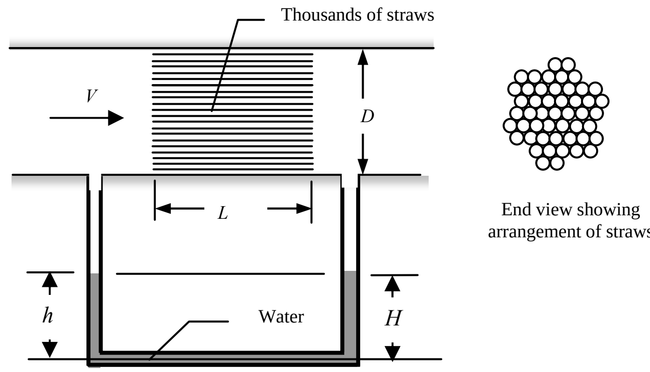
1 Btu/lbm = 25037 ft^2/s^2

1 ft·lbf /lbm = 32.174 ft^2/s^2

Problem 1 (10 points)

For straightening and smoothing air flowing in a constant diameter duct, the duct is packed with a "honeycomb" of thin straws as shown in the figure. Two different pressure measuring set-ups are used in the ducts as shown in the figures below.

Answer (a) and (b) for the figure on the right.



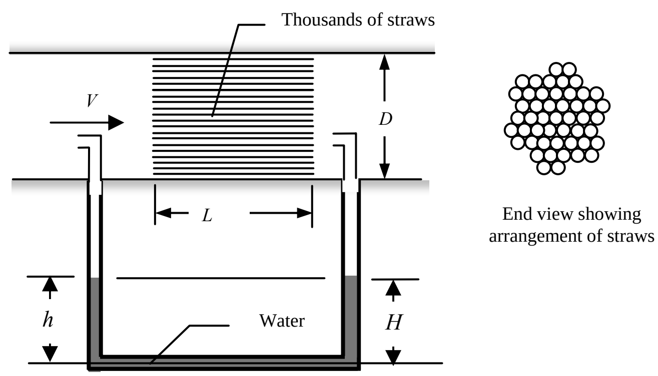
(a) (2 points) When the air velocity $V = 0$, which of the following is correct?

Circle one: $h < H$ $h = H$ $h > H$

(b) (4 points) When the air velocity $V > 0$, which of the following is correct?

Circle one: $h < H$ $h = H$ $h > H$

Answer (c) for the figure on the right



(c) (4 points) When the air velocity V in the duct is the same as in Part (b), which of the following is correct?

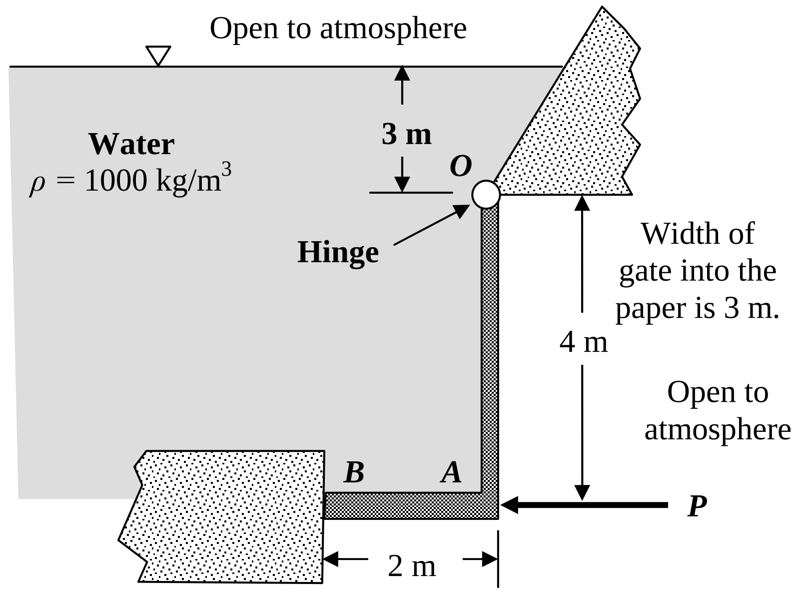
Circle one: $h < H$ $h = H$ $h > H$

Problem 2 (45 points)

The rigid gate, *OAB,* is hinged at *O* and rests against a rigid support at *B*. The back of the gate is exposed to the atmosphere.

Determine the *minimum* horizontal force, ***P***, required to hold the gate closed if its width (into the page) is 3 meters.

Neglect the weight of the gate and assume the hinge is frictionless.



Problem 3 (45 points)

Pressurized water is supplied to a nuclear reactor vessel from reservoir tank. The reservoir tank is open to the atmosphere at 100 kPa (abs). The reactor vessel is maintained at a pressure of 200 kPa (gage). The water is pumped from the reservoir to the reactor vessel as shown in the figure. The pipe is commercial steel with an inside diameter of 0.15 m and a total length of 200 m. The velocity of the water in the piping is 10 m/s. All other fittings are shown in the figure. Pertinent elevation information is provided in the figure.

Water Properties:	Dynamic viscosity $\mu = 1 \times 10^{-3}$ kg/(m-s);	Density $\rho = 1000$ kg/m^3

Determine the power required to operate the pump if it is 100% efficient.