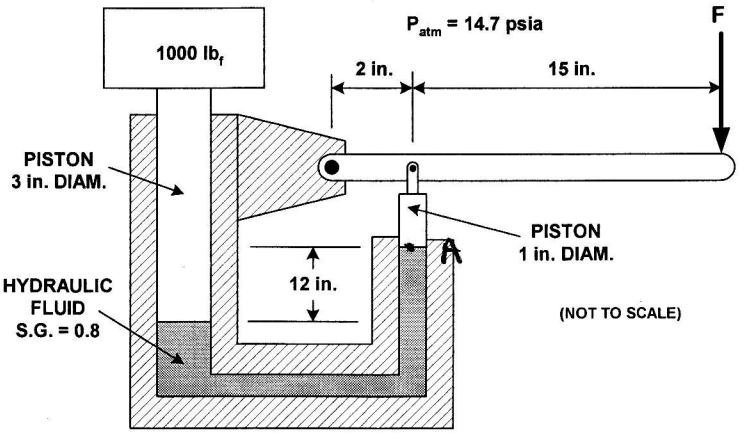
Department of Mechanical and Aerospace Engineering
CARLETON UNIVERSITY
MAAE 2300 Fluid Mechanics I
Midterm Examination - November 2011 - Duration: 1 ½ hours

ATTEMPT ALL 3 QUESTIONS. THE VALUE OF EACH QUESTION IS GIVEN IN THE MARGIN. PLEASE USE <u>BOTH</u> SIDES OF THE PAGE IN THE ANSWER BOOKLET.

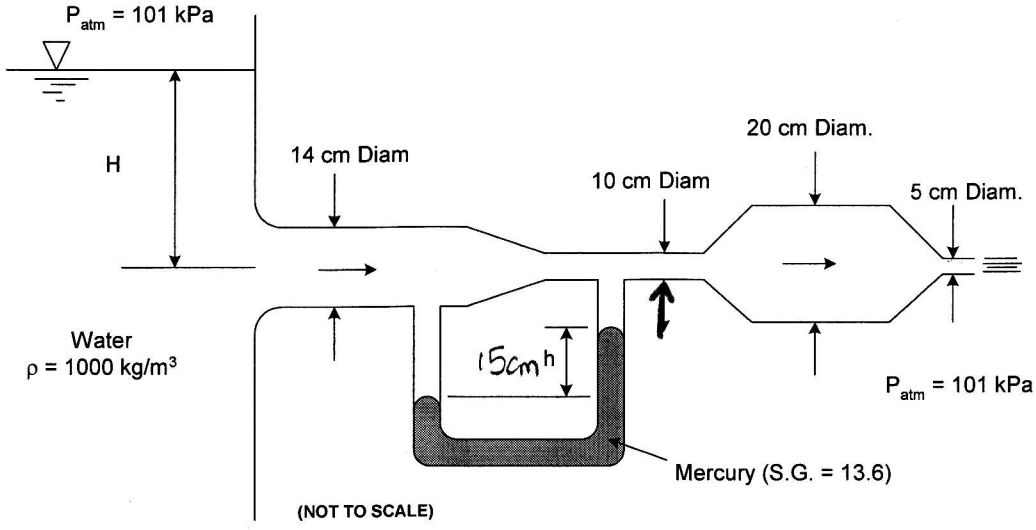
$g = 9.81\ m/s^2 = 32.174\ ft/sec^2$ $\rho_{water} = 1{,}000\ kg/m^3 = 62.4\ lb_m/ft^3$ $R_{air} = 287\ J/kgK$
$1\ slug = 32.174\ lb_m$ $1\ ft. = 12\ in.$

1. The drawing shows a simple hydraulic jack. The hydraulic fluid has a specific gravity (S.G.) of 0.8. Determine the force F that must be applied to the handle to support the 1000 lb_f weight. Neglect the weight of the two pistons.

[15]



2. Water flows through the system shown in the drawing. For your analysis assume one-dimensional flow and neglect friction and all other losses in the system. Determine the height of water, H, in the tank if h = 15 cm for the mercury U-tube manometer.



[20]

(Continued ...)

down is -ve height

3. The drawing shows a two-outlet nozzle that is used to spray water inside a closed tank containing a pressurized gas. For a volume flow rate of water is 0.1 m^3/s and with a gas pressure inside the tank of 300 kPa(a), the pressure gauge on the inlet pipe indicates a pipe pressure of 250 kPa(g) in the water. The velocity at the outlet of the two nozzles is expected to be the same: $V_1 = V_2$. The pipe supplying the water is horizontal. The drawing is a plan view and thus the weight of the nozzle and the weight of the water inside it will act in the negative z direction for the co-ordinate system shown. The flow may be assumed to be one-dimensional everywhere.

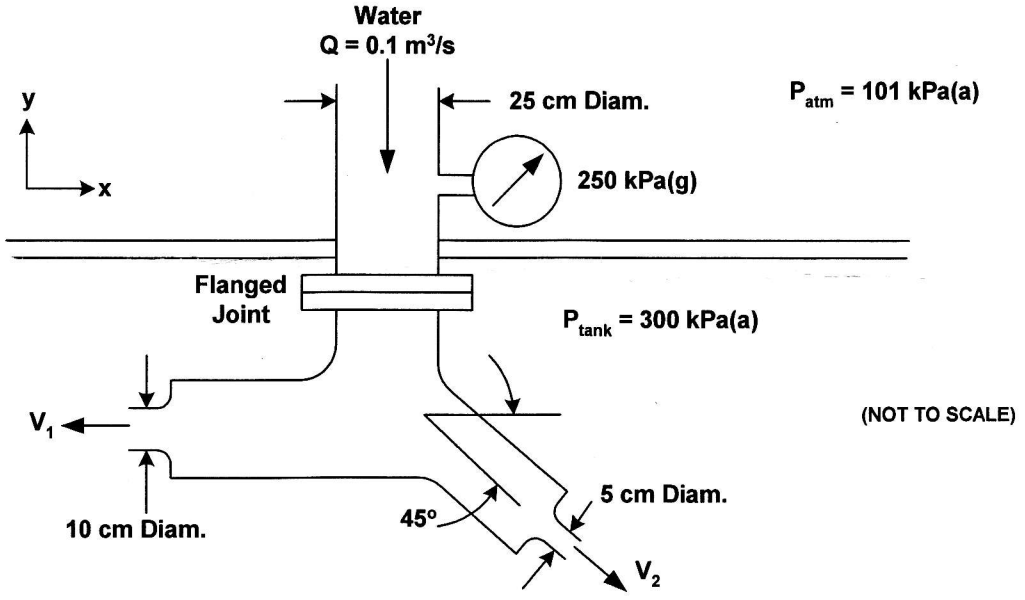
[4] (a) What is the velocity at the outlet of the two nozzles, V_1 and V_2, in m/s?

[6] (b) Draw and fully label a control volume that can be used to solve for the forces in the x and y directions at the flanged joint shown. The diagram should show the values of all flow quantities (pressures, velocities, etc.) needed to solve for the forces.

[12] (c) Determine the forces in the flanged joint in the x and y directions.

[3] (d) Is the flanged joint in tension or compression? Briefly explain your reasoning.

[25]



[60]