Practice Problems Set -1

ME-231A

P1. For low-speed (laminar) flow in a tube of radius r_o, the velocity u takes the form

$$u = B\frac{\Delta p}{\mu}\left(r_o^2 - r^2\right)$$

where μ is viscosity and Δp the pressure drop. What are the dimensions of B?

P2. The velocity distribution for laminar flow between parallel plates is given by

$$\frac{u}{u_{max}} = 1 - \left(\frac{2y}{h}\right)^2$$

where h is the distance separating the plates and the origin is placed midway between the plates. Consider a flow of water at 15°C, with u_{max}=0.10 m/s and h=0.1 mm. Calculate the shear stress on the upper plate and give its direction. Sketch the variation of shear stress across the channel.

P3. Determine the gage pressure in kPa at point a, if liquid A has SG = 1.20 and liquid B has SG = 0.75. The liquid surrounding point a is water, and the tank on the left is open to the atmosphere.

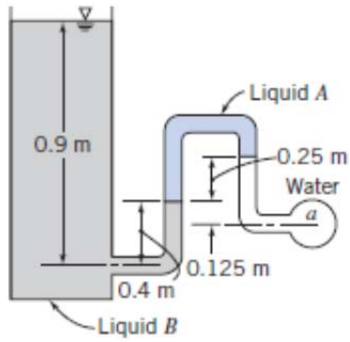

Fig.P3

P4. In Fig.P4 all fluids are at 20°C. Determine the pressure difference (Pa) between points *A* and *B*.

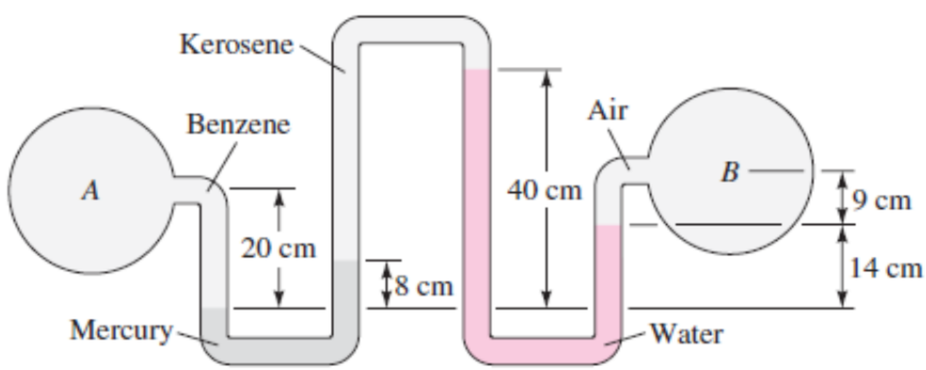

Fig.P4

P5. Water flows downward in a pipe at 45°, as shown in Fig. P5. The pressure drop P_1 -P_2 is partly due to gravity and partly due to friction. The mercury manometer reads a 6-in height difference. What is the total pressure drop P_1 - P_2 . What is the pressure drop due to friction only between 1 and 2?

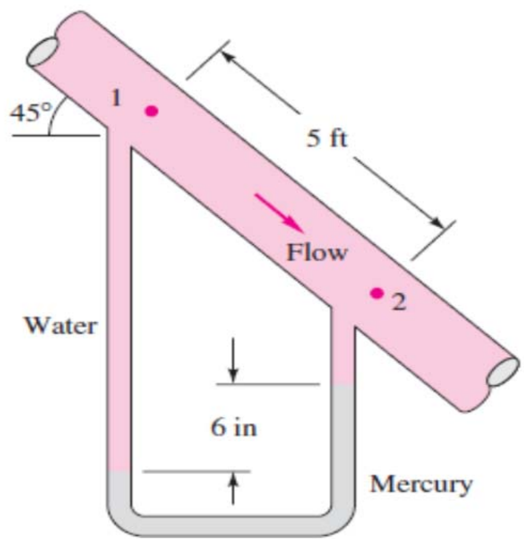

Fig.P5

P6. In Fig.P6 the pressures at *A* and *B* are the same, 100 kPa. If water is introduced at *A* to increase P_A to 130 kPa, find and sketch the new positions of the mercury menisci. The connecting tube is a uniform 1-cm diameter. Assume no change in the liquid densities.

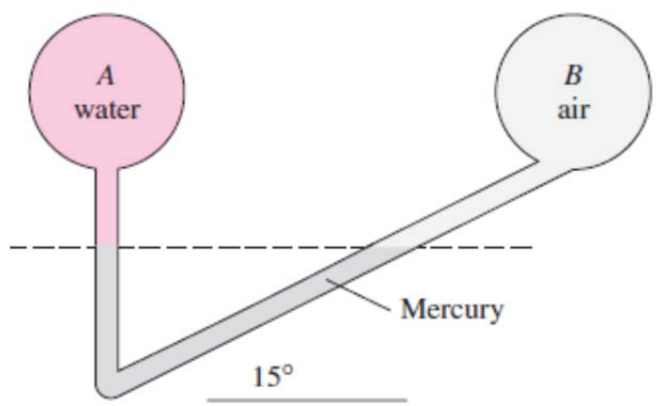

Fig.P6

P7. Gate *AB* in Fig.P7 is 1.2 m long and 0.8 m into the paper. Neglecting atmospheric pressure, compute the force *F* on the gate and its center-of-pressure position *X*.

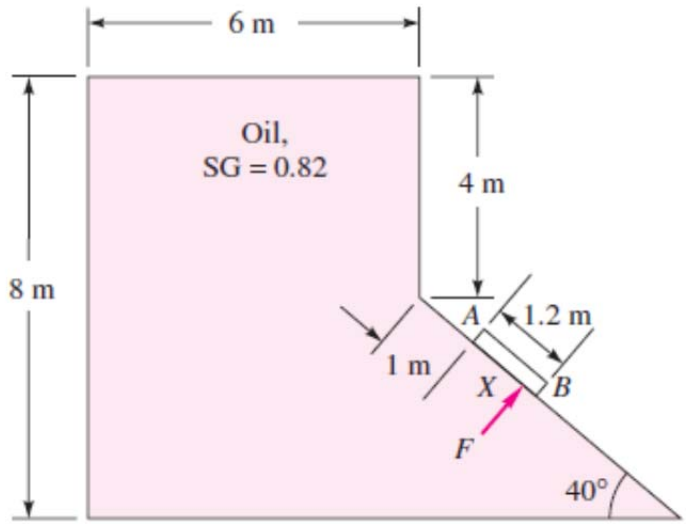

Fig.P7

P8. Gate *AB* in Fig.P8 is a homogeneous mass of 180 kg, 1.2 m wide into the paper, hinged at *A*, and resting on a smooth bottom at *B*. All fluids are at 20°C. For what water depth *h* will the force at point *B* be zero?

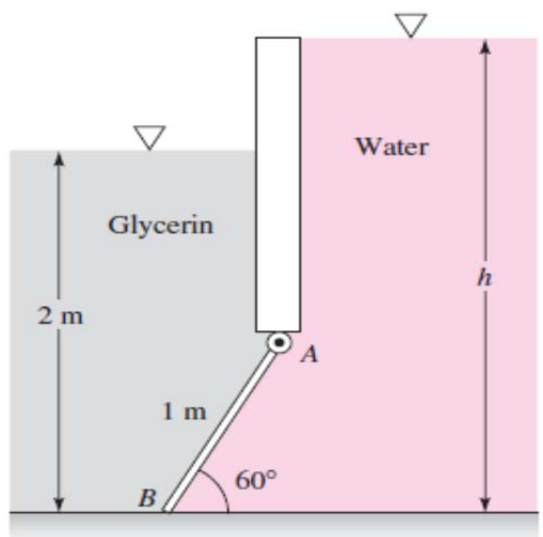

Fig.P8

P9. The tank in Fig. P9 has a 4-cm-diameter plug at the bottom on the right. All fluids are at 20°C. The plug will pop out if the hydrostatic force on it is 25 N. For this condition, what will be the reading *h* on the mercury manometer on the left side?

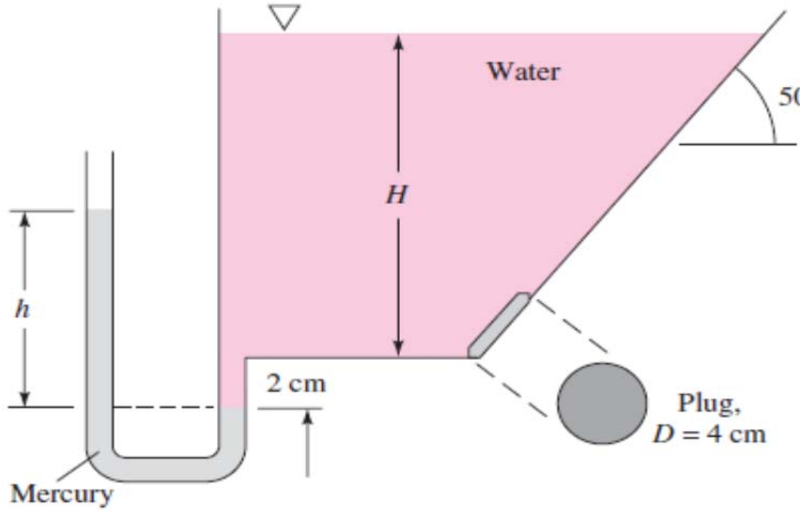

Fig.P9

P10. The dam in Fig.P10 is a quarter circle 50 m wide into the paper. Determine the horizontal and vertical components of the hydrostatic force against the dam and the point CP where the resultant strikes the dam.

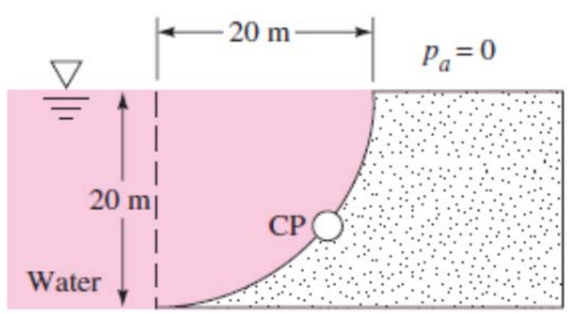

Fig.P10

P11. The gate shown is hinged at H. The gate is 3 m wide normal to the plane of the diagram. Calculate the force required at A to hold the gate closed

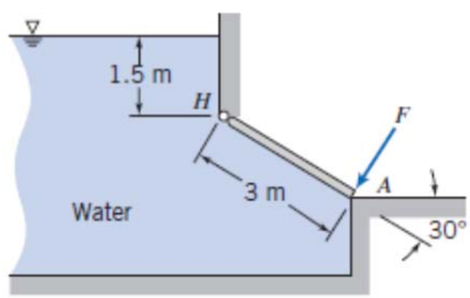

Fig.P11

P12. Consider the cylindrical weir of diameter 3 m and length 6 m. If the fluid on the left has a specific gravity of 1.6, and on the right has a specific gravity of 0.8, find the magnitude and direction of the resultant force.

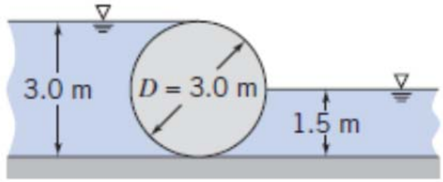

Fig.P12

P13. An open tank is filled to the top with water. A steel cylindrical container, wall thickness δ=1 mm, outside diameter D=100 mm, and height H=1 m, with an open top, is gently placed in the water. What is the volume of water that overflows from the tank? How many 1 kg weights must be placed in the container to make it sink? Neglect surface tension effects.

P14. A block of volume 0.025 m^3 is allowed to sink in water as shown. A circular rod 5 m long and 20 cm^2 in cross-section is attached to the weight and also to the wall.
(a) If the rod mass is 1.25 kg and the rod makes an angle of 12 degrees with the horizontal at equilibrium, what is the mass of the block?
(b) If the mass M is released from the rod, at equilibrium how much of the rod will remain submerged? What will be the minimum required upward force at the tip of the rod to just lift it out of the water?

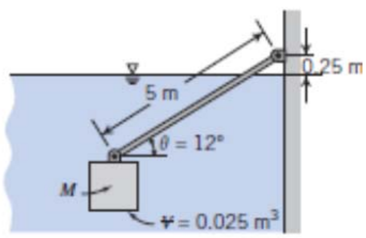

Fig.P14

P15. A bowl is inverted symmetrically and held in a dense fluid, SG=15.6, to a depth of 200 mm measured along the centerline of the bowl from the bowl rim. The bowl height is 80 mm, and the fluid rises 20 mm inside the bowl. The bowl is 100 mm inside diameter, and it is made from an old clay recipe, SG=6.1. The volume of the bowl itself is about 0.9 L. What is the force required to hold it in place?

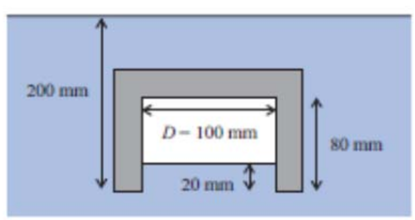

Fig.P15

P16. Consider a wooden cylinder (SG = 0.6) 1 m in diameter and 0.8 m long. Would this cylinder be stable if placed to float with its axis vertical in oil (SG = 0.85)?