Fluid Mechanics Assignment 2

Hydrostatics

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1. For a non-isothermal atmosphere, find out the relationship between p and z. The expression for temperature variation with height is given by $T \approx T_0 - BZ$, where T_0 is the sea level temperature (absolute) and B is the lapse rate.

2. In Fig.Q2 the tank contains water and immiscible oil at 20°C. What is h in centimeters if the density of the oil is 898 kg/m^3?

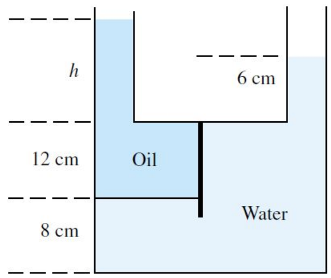

Figure Q2:

3. For a liquid, integrate the hydrostatic relation ($\frac{dp}{dz} = -\gamma$) by assuming that the isentropic bulk modulus, $B = \rho(\frac{\partial p}{\partial \rho})_s$ is constant. Find an expression for $p(z)$. (Hint: eliminate ρ to obtain the desired pressure-depth relation)

4. A closed inverted cone, 100 cm high with diameter 60 cm at the top, is filled with air at 20°C and 1 atm. Water at 20°C is introduced at the bottom (the vertex) to compress the air isothermally until a gage at the top of the cone reads 30 kPa (gage). Estimate (a) the amount of water needed (cm^3) and (b) the resulting absolute pressure at the bottom of the cone (kPa).

5. The fuel gage for a gasoline tank in a car reads proportional to the bottom gage pressure as in Fig.Q5. If the tank is 30 cm deep and accidentally contains 2 cm of water plus gasoline, how many centimeters of air remain at the top when the gage erroneously reads "full"?

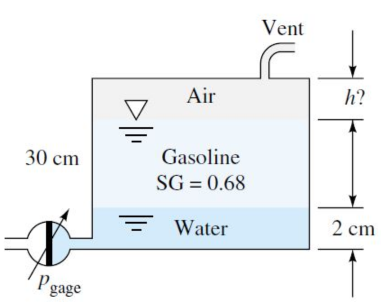

Figure Q5:

6. The inclined manometer in Fig.Q6 contains Meriam red manometer oil, SG = 0.827. Assume that the reservoir is very large. If the inclined arm has graduations 1 inch apart, what should θ be if each graduation represents 1 lbf/ft^2 gage pressure for p_A?

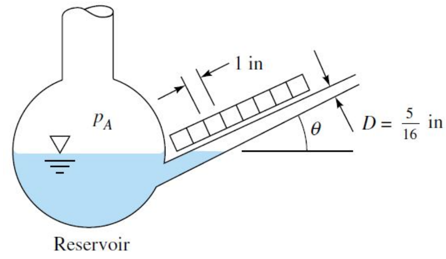

Figure Q6:

7. In Fig.Q7 determine Δp between points A and B. All fluids are at 20°C.

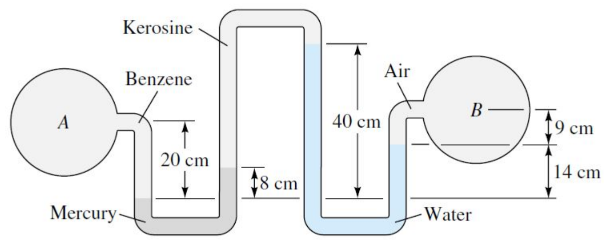

Figure Q7:

8. Water flows downward in a pipe at 45°, as shown in Fig.Q8. The mercury manometer reads a 6-in height. The pressure drop p_2-p_1 is partly due to friction and partly due to gravity. Determine the total pressure drop and also the part due to friction only. Which part does the manometer read? Why?

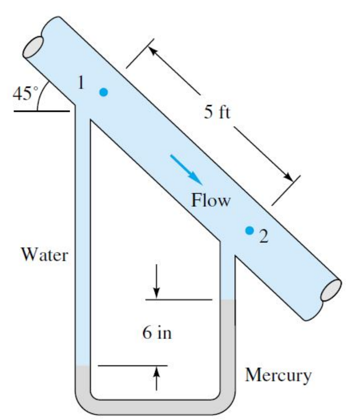

Figure Q8:

9. Gate AB has length L, width b into the paper, is hinged at B, and has negligible weight. The liquid level h remains at the top of the gate for any angle θ. Find an analytic expression for the force P, perpendicular to AB, required to keep the gate in equilibrium in Fig.Q9.

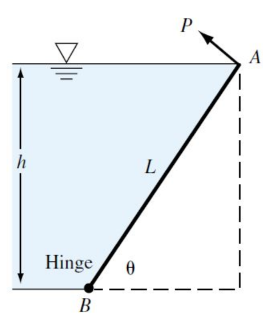

Figure Q9:

10. Gate AB in Fig.Q10 is a homogeneous mass of 180 kg, 1.2 m wide into the paper, hinged at A, and resting on smooth bottom B. All fluids are at 20°C. For what water depth h will the force at point B be zero?

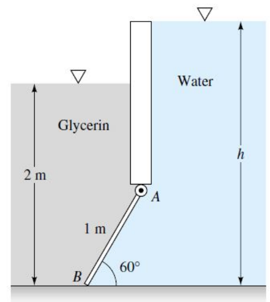

Figure Q10:

11. The tank in Fig.Q11 has a 4-cm diameter plug which will pop out if the hydrostatic force on it reaches 25 N. For 20°C fluids, what will be the reading h on the manometer when this happens?

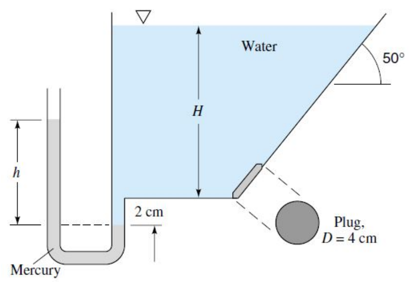

Figure Q11:

12. Gate AB in Fig.Q12 is semicircular, hinged at B, and held by a horizontal force P at point A. Determine the required force P for equilibrium.

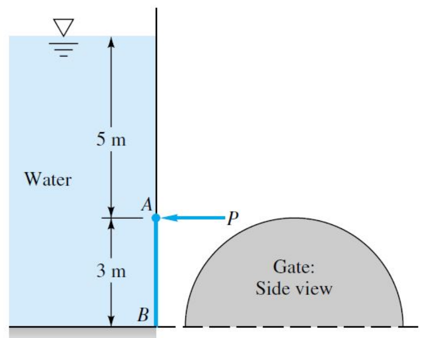

Figure Q12:

13. The V-shaped container in Fig.Q13 is hinged at A and held together by cable BC at the top. If the cable spacing is 1 m into the paper, what is the cable tension?

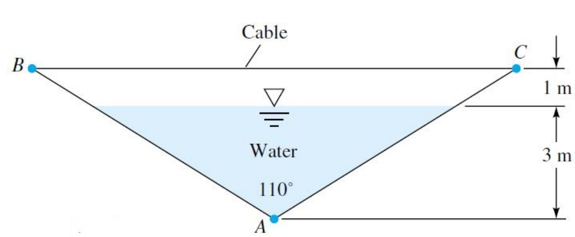

Figure Q13:

14. The 4-ft-diameter log (SG=0.80) in Fig.Q14 is 8 ft long into the paper and dams water as shown. Compute the net vertical and horizontal reactions at point C.

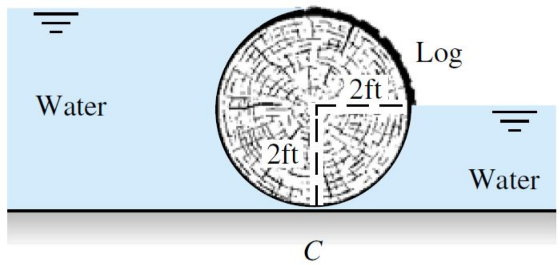

Figure Q14:

15. A uniform block of steel (SG=7.85) will “float” at a mercury-water interface as in Fig.Q15 What is the ratio of distances a and b for this condition?

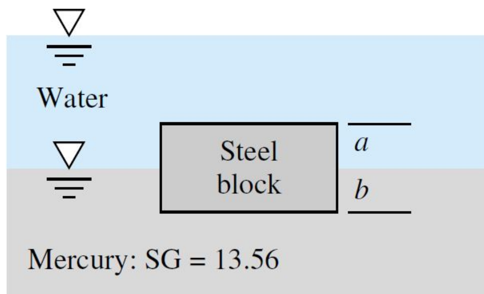

Figure Q15:

16. The iceberg of Fig.Q16 can be idealized as a cube of side length L as shown. If seawater is denoted as $S = 1$, the iceberg has S = 0.88. Is it stable?

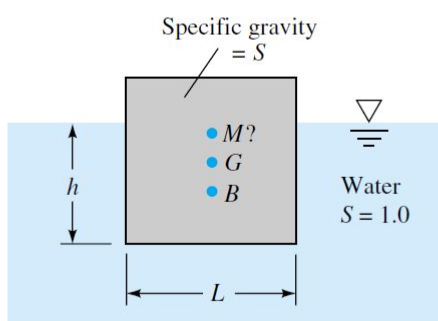

Figure Q16:

17. A barge is 15 ft wide and 40 ft long and floats with a draft of 4 ft. It is piled so high with gravel that its center of gravity is 2 ft above the waterline. Is it stable?

18. Consider a uniform right circular cone of specific gravity $S < 1$, floating with its vertex down in water ($S = 1.0$). The base radius is R and the cone height is H. Calculate and plot the stability parameter MG of this cone, in dimensionless form, versus H/R for a range of $S < 1$.