

8.01 Quiz 9, Fall 1994

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3. (25 Points)

The diagram shows a horizontal tube with two sections of different cross-sectional areas, A_1 and A_2 . The tube is connected to a U-tube manometer. The manometer contains a liquid of density ρ_2 . The flowing liquid has density ρ_1 . The height difference between the two liquid levels in the U-tube is h . The flow rate is R . Points B, C, D, and E are marked on the diagram.

An incompressible liquid of density ρ_1 is flowing, with laminar flow, through a tube at a volume rate of R . The tube consists of two parts; the first has cross-sectional area A_1 , and the second A_2 . The two sections are connected by a U-tube as shown above. The U-tube is partially filled with a liquid of density ρ_2 ($\rho_2 > \rho_1$) which does not mix with the flowing liquid. The difference in height of the boundary between the two liquids on the two sides of the U-tube is h . Derive an expression for h in terms of R , A_1 , A_2 , ρ_1 , ρ_2 , and g .