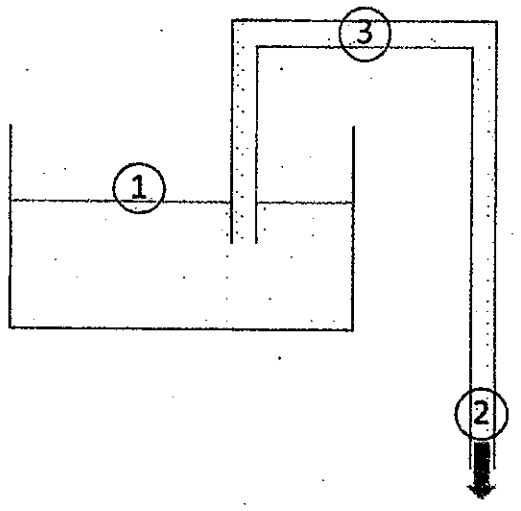
1 Explain the dependence of pressure drop on fluid viscosity, velocity, and surface roughness. Support your explanation with sketches or equations as you see fit. [25 pts]

2 Two liquids, acetonitrile (density = 0.786 g/cm3) and dichloromethane (density = 1.33 g/cm3), are flowing between two parallel plates at constant flow condition. Sketeh the velocity profiles of both liquids, supposing that each fluid occupies half of the inter-plate space and both are at laminar flow. Label and explain the velocity profiles. [25 pts]

3 A hose of diameter 3 cm is used to drain a tank filled with trichloroethylene. The hose is draped over the side of the tank so that the fluid is siphoned out. If the hose discharge is 1 m below the surface of the fluid, estimate the mass flow rate assuming frictional effects in the fluid are negligible. State all of your assumptions. Dr. X comes along and tells you the trichloroethylene is boiling in the hose. Can this be possible? If so, where, and under what conditions might this happen? [20 pts]



4 For a given head loss per unit length, what effect on the flowrate does doubling the pipe diameter have if the flow is (a) laminar, or (b) completely turbulent? How will the flow conditions influence the application of Bernoulli's equation? Please comment. [10 pts]

5 Consider the uniform viscous flow of an incompressible fluid past a porous plate (i.e., the width of the plate is assumed to be infinite 2-D flow) through which fluid is drawn with a velocity V. It can be shown that the velocity profile for this flow is given by,

$U_x = U_\infty\left(1 - e^{(V \cdot y \cdot \rho)/\mu}\right);\ U_y = -V$.

Determine the thickness of the hydrodynamic boundary layer. How does the thickness of the boundary layer scale with Reynolds number (Re)? [20 pts]

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