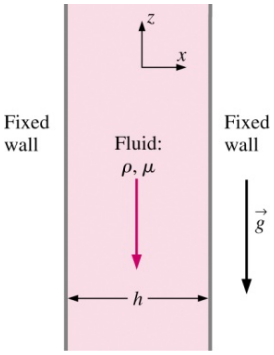
November 10, 2014

NAME

Fluids-ID

Quiz 10. Consider a steady, incompressible, parallel, laminar flow of a viscous fluid falling between two infinite, vertical walls as shown in Figure. The distance between the walls is h, and gravity acts in the negative z-direction ($g_z = -g$, downward in the figure). There is no forced pressure ($\partial p/\partial z = 0$) driving the flow – the fluid falls by gravity alone. Starting from the following Navier-Stokes equation,



$$\rho\left(\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial x}+v\frac{\partial w}{\partial y}+w\frac{\partial w}{\partial z}\right)=-\frac{\partial p}{\partial z}+\rho g_z+\mu\left(\frac{\partial^2 w}{\partial x^2}+\frac{\partial^2 w}{\partial y^2}+\frac{\partial^2 w}{\partial z^2}\right)$$

(a) drive an expression for w and (b) calculate the centerline velocity (w along the $x = 0$ line) if $h = 2$ mm and the fluid is glycerin at 20°C ($\rho = 1{,}260$ kg/m^3 and $\mu = 1.49$ N·s/m^2). Assume the flow is purely two-dimensional ($v = 0$ and $\partial/\partial y = 0$) and parallel to the walls ($u = 0$).

Note: Attendance (+2 points), format (+1 point)